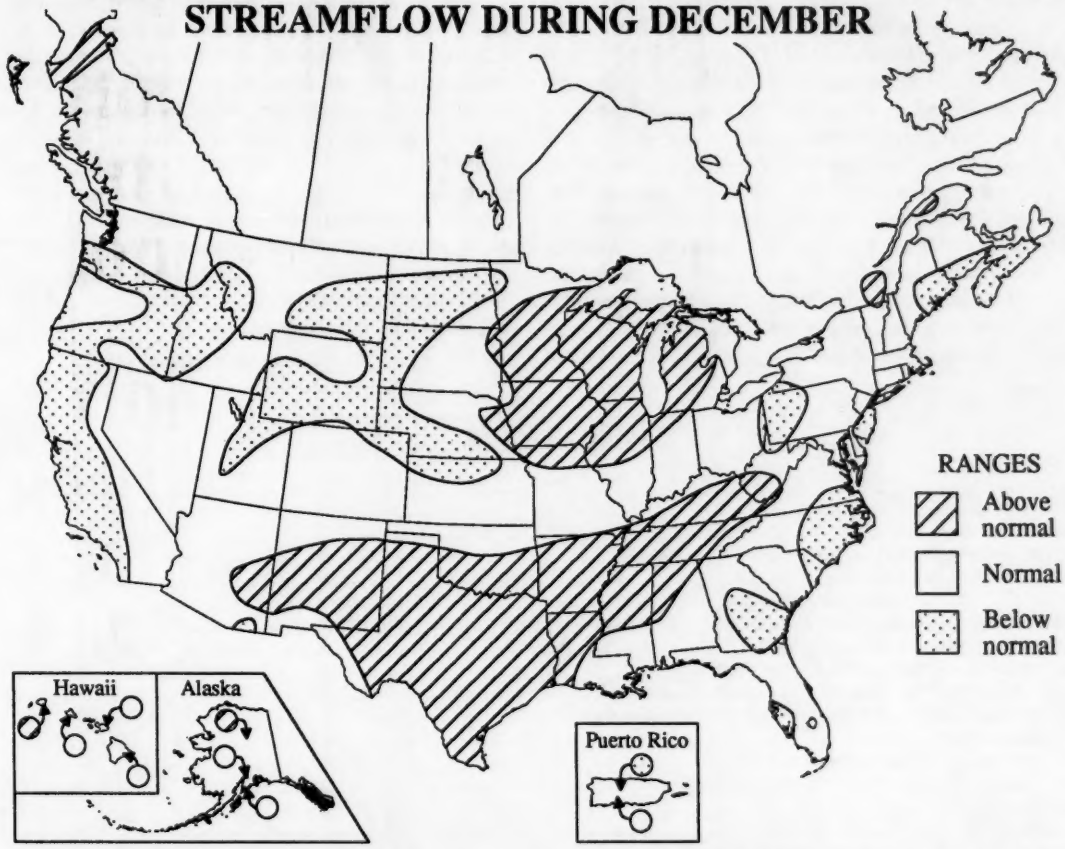
National Water Conditions

UNITED STATES
Department of the Interior
Geological Survey

CANADA
Department of the Environment
Water Resources Branch

DECEMBER 1991

STREAMFLOW DURING DECEMBER



A moderate rain which began falling on Kauai, Hawaii, on Friday, December 14, intensified significantly during the early morning hours of December 15, causing significant flooding in the northeastern part of the island. Three fatalities occurred as a direct result of the flooding and damage estimates are in excess of $7 million.

Severe flooding occurred over a large area of Texas, following six days of almost continuous rainfall December 17-23. Flooding occurred at 163 streamflow stations, most of which were in the Trinity, Brazos, Colorado, and Guadalupe River basins. Historical peak stages or discharges (at least three prior to 1900) were exceeded at 17 streamflow stations and record stages or contents occurred at 5 major reservoirs.

However, drought continued to affect parts of the United States and southern Canada. The contents of the New York City Reservoir System were only 73 percent of the long-term average for the end of December and almost 40 percent lower than contents at the end of December 1990. In California, total streamflow for December at the six reporting index stations was 65 percent below median, despite a 26 percent increase from November.

December streamflow declined from that for November at 78 index stations, remained unchanged at 4 index stations, and increased at 111 index stations, resulting in normal to above-normal range streamflow at 77 percent of the index stations during the month. Below-normal range streamflow occurred in 17 percent of the area of the conterminous United States and southern Canada during December. Total December flow for the reporting index stations in the conterminous United States and southern Canada was 3 percent above median.

The combined flow of the 3 largest rivers in the lower 48 States--Mississippi, St. Lawrence, and Columbia--averaged 40 percent above median and in the above-normal range.

Month-end index reservoir contents were in the below-average range at 29 sites, compared with 32 at the end of November. Contents were in the above-average range at 44 reservoirs.

Mean December elevations at four master gages on the Great Lakes (provisional National Ocean Service data) were in the normal range except on Lake Ontario, where levels were in the below-normal range.

Utah's Great Salt Lake ended the month at 4,201.70 feet above National Geodetic Vertical Datum, 0.10 foot higher than at the end of November, the entire rise occurring after December 15.

SURFACE-WATER CONDITIONS DURING DECEMBER 1991

Severe floods occurred in Hawaii (see page 3) and Texas (see pages 4-5) during December, with floods of record and the 100-year flood exceeded at many streamflow stations in the two States. However, drought continued to affect parts of the United States and southern Canada, with the largest areas of below-normal range streamflow located in the West and the East. The contents of the New York City Reservoir System increased, rising from 51 percent of capacity at the end of November to 57 percent of capacity at the end of December (only 73 percent of the long-term average for the end of December), almost 40 percent lower than contents at the end of December 1990. In California, total streamflow, reservoir contents, and ground-water levels remained well-below average. Total streamflow for December at the six reporting index stations in California was 65 percent below median despite a 26 percent increase from that for November. The persistence and severity of the drought in California is shown by the following: (1) since the end of August 1990 (the most recent month of above-median streamflow), the cumulative streamflow deficit at the six index stations has gone from about 68 percent of a median year of runoff to about 119 percent of a median year of runoff—over half of a median year of runoff was "lost" in the last 16 months; (2) the seasonal lows in combined storage for six large index reservoirs have generally declined steadily since 1986, bottoming out at 69, 53, 43, 45, and 33 percent of capacity, with combined storage currently at 31 percent of capacity. (Conditions in California are also discussed on page 24.)

December streamflow declined from that for November at 78 index stations, remained unchanged at 4 index stations, and increased at 110 index stations, resulting in normal to above-normal range streamflow at 77 percent of the 192 index stations in the United States, southern Canada, and Puerto Rico during the month, compared with 77 percent of stations in those ranges during November, and 76 percent of stations in those ranges during December 1990. Below-normal range streamflow occurred in 17 percent of the area of the conterminous United States and southern Canada during December, compared with 12 percent during November, and 27 percent during December 1990. Total December flow of 590,900 cubic feet per second (ft^3/s) for the 174 reporting index stations in the conterminous United States

(Continued on page 7)

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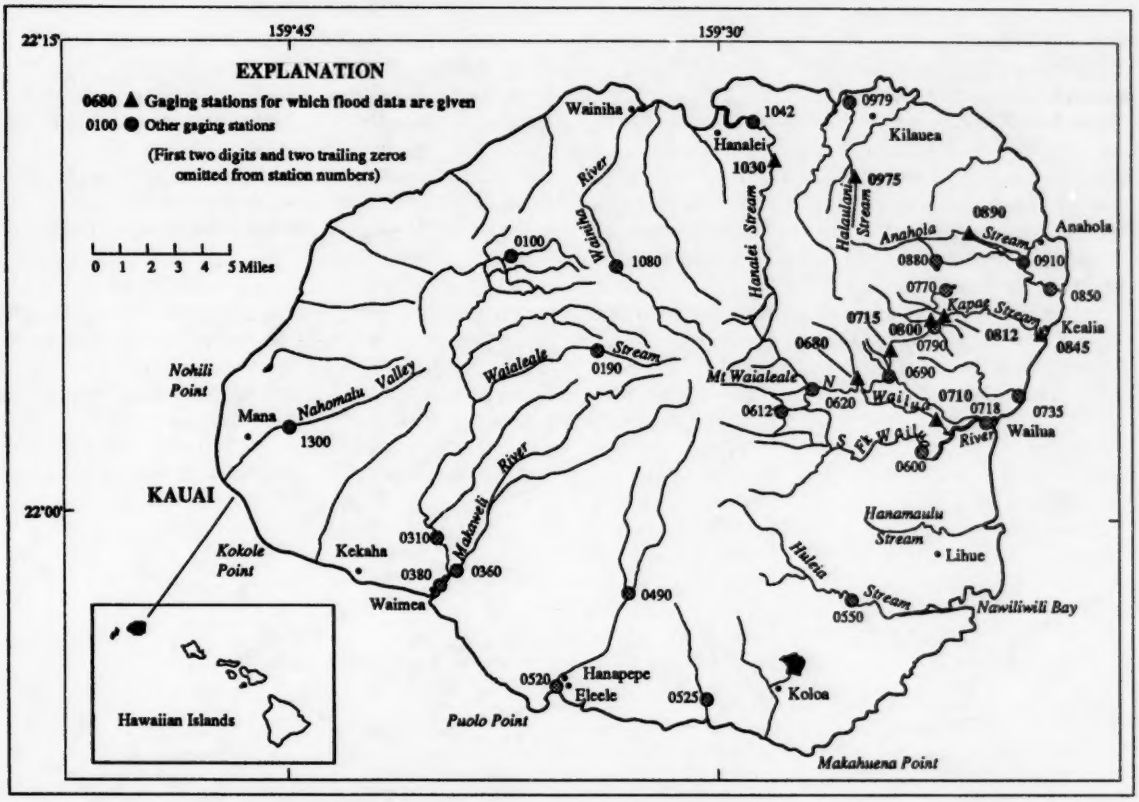
FLOODS OF DECEMBER 14, 1991, ON KAUAI, HAWAII



A moderate rain which began falling on Friday, December 14, 1991, over most sections of Kauai, intensified significantly during the early morning hours of December 15. In northeastern Kauai, rain fell at a rate of up to 2 inches per hour from midnight to 3 a.m., with as much as 1.08 inches in one 15-minute period at the National Weather Service gage at Wailua. Preliminary data indicate storm totals in excess of 15 inches in northeastern Kauai.

Flooding was especially severe in the Anahola, Aliomanu, Moloaa, and Kapaa areas of northeastern Kauai. Three fatalities occurred as a direct result of the flooding and damage estimates are in excess of $7 million.

Provisional data; subject to revision

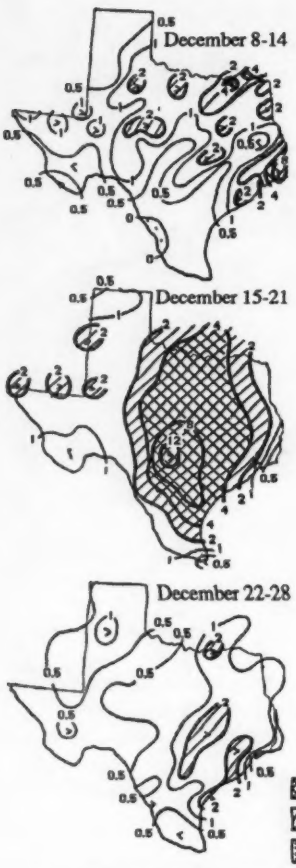
FLOOD DATA FOR SELECTED SITES IN NORTHEASTERN KAUAI, HAWAII, DECEMBER 1991

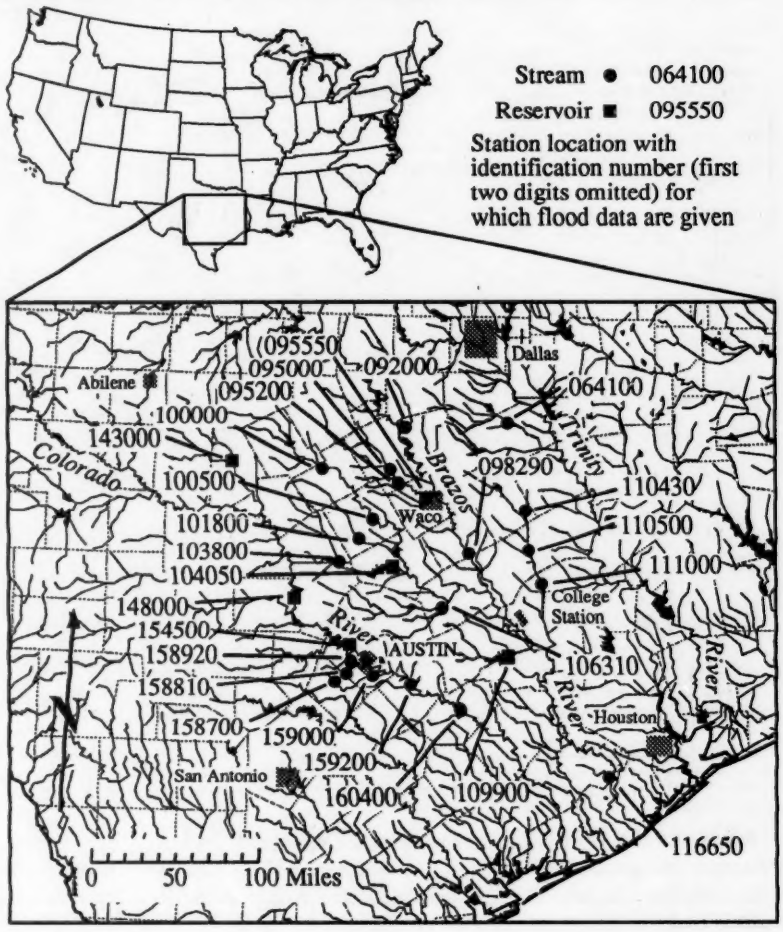
WRD Station number	Stream and place of determination	Drainage area (square miles)	Period of known floods	Maximum flood previously known			Maximum during present flood				
							Discharge				
				Date	Stage (feet)	Discharge (cfs)	Date	Stage (feet)	Cfs	Cfs per square mile	Recurrence interval (years)
16068000	East Branch of North Fork Wailua River near Lihue	6.27	1916–	Nov. 12, 1955	[1]14.7	18,400	Dec. 14	10.85	9,000	1,440	55
16071000	North Fork Wailua River near Kapaa	17.9	1953–	Nov. 12, 1955	19.88	53,200	14	16.02	32,000	1,790	55
16071500	Left Branch Opaekaa Stream near Kapaa	.65	1961–	Jan. 31, 1975	5.58	724	14	6.60	1,300	2,000	[2]1.38
16080000	Kapaa Stream at Kapahi ditch intake, near Kapaa	3.86	1937–	Jan. 25, 1956	5.34	7,670	14	5.66	9,200	2,380	[2]1.23
16081200	Akulikuli Stream near Kapaa	.40	1964–	Oct. 30, 1982	7.64	780	14	[1]10.7	3		
16084500	Kapaa Stream at old highway crossing, near Kealia	14.0	1962–	Oct. 30, 1982	18.02	17,600	14	[1]23.4	31,000	2,210	[2]1.11
16089000	Anahola Stream near Kealia	4.27	1914–	Jan. 25, 1956	14.60	19,600	14	[1]16.2	21,000	4,920	[2]1.42
16097500	Halaulani Stream at altitude 400 feet, near Kilauea	1.90	1958–	July 23, 1989	7.69	2,420	14	9.64	4,500	2,370	[2]1.59
16103000	Hanalei River near Hanalei	19.1	1962-	Apr. 19, 1974	14.28	24,900	14	14.45	25,500	1,340	10

[1] From floodmarks.
[2] Recurrence interval greater than 100 years. Value shown is approximate ratio of discharge to that of 100-year flood.
[3] Unable to estimate peak discharge.

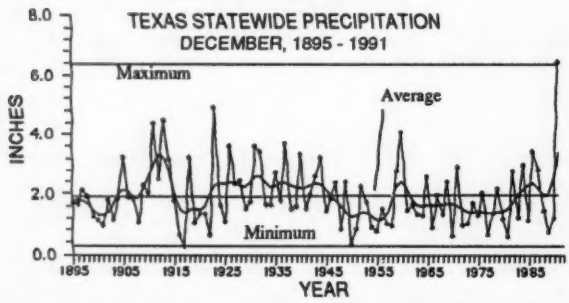
FLOODS OF DECEMBER 1991-JANUARY 1992 IN TEXAS

Total Weekly Precipitation, Inches
(from *Weekly Weather and Crop Bulletin* prepared and published by the NOAA/USDA Joint Agricultural Weather Facility)





According to the *Climate Variations Bulletin*, "precipitation in Texas was a major news maker near the end of the month. As can be seen below, December 1991 average precipitation was of an unprecedented value and numerous individual rainfall totals in excess of a foot for the month were reported."



(From *Climate Variations Bulletin*, National Climatic Data Center, NOAA)

Severe flooding occurred over a large area of Texas, following six days of almost continuous rainfall December 17-23. Amounts of 10-15 inches fell over much of Texas during that period, with 5-8 inches falling between the evening of December 21 and the morning of December 22. As a result, flooding occurred from Dallas, in north-central Texas, to the coastal plains of south-central Texas, and from west Texas, near San Angelo, to east Texas near the State line.

Major flooding occurred at 163 streamflow stations, most of which were in the Trinity, Brazos, Colorado, and Guadalupe River basins. Historical peak stages or discharges (at least three prior to 1900) were exceeded at 17 streamflow stations and record stages or contents occurred at 5 major reservoirs. Recurrence intervals are not yet available for some streams. The map above shows both streamflow and reservoir stations at which record peak discharges or contents occurred. Data for those sites shown on the map are given in the tables on the facing page.

As of January 2, 1992, five counties (Bastrop, Bosque, Brown, Dallas, and Travis) were declared disaster areas. Sixteen fatalities and damages of about $75 million were attributed to the storm.

Provisional data; subject to revision

FLOOD DATA FOR SELECTED STREAMS IN TEXAS, DECEMBER 1991

WRD Station number	Stream and place of determination	Drainage area (square miles)	Period of known floods	Maximum flood previously known: Date	Stage (feet)	Discharge (ft^3/s)	Maximum during present flood: Date	Stage (feet)	Discharge: ft^3/s	Discharge: ft^3/s per square mile	Recurrence interval (years)
	TRINITY RIVER BASIN										
08064100	Chambers Creek near Rice	807	1870-	June 6, 1986	31.12	43,400	Dec. 21	32.85	[1]65,000	80.5	(2)
	BRAZOS RIVER BASIN										
08092000	Nolan River at Blum	282	1887-	May 7, 1969	31.23	62,200	20	31.55	[1]63,000	223	100
				May 8, 1922	[3]35.0	(2)					
08095000	North Bosque River near Clifton	968	1854-	Oct. 4, 1959	34.88	92,800	20	38.34	[1]180,000	186	[4]2.9
08095200	North Bosque River near Valley Mills	1,146	1868-	Oct. 4, 1959	40.22	107,000	21	44.53	[1]200,000	175	[4]1.6
				May 1908	[3]43	(2)					
08098290	Brazos River near Highbank	[5]30,436	1909-	Feb. 4, 1986	23.90	78,700	22	30.78	[1]74,000	2.43	25
				Dec. 1913	[3]42	(2)					
08100000	Leon River near Hamilton	1,891	1858-	May 4, 1990	33.26	24,000	20	35.04	[1]40,000	21.2	100
				May 1908	[3]38.4	(2)					
				Dec. 1913							
08100500	Leon River at Gatesville	2,342	1854-	Oct. 4, 1959	34.14	51,200	21	34.87	[1]60,000	25.6	75
				May 1908	[3]35	(2)					
08101000	Cowhouse Creek at Pidcoke	455	1882-	Oct. 4, 1959	40.1	66,200	20	45.5	[1]160,000	352	2.4
08103800	Lampasas River near Kempner	818	1871-	May 16, 1965	32.98	71,000	20	35.00	[1]85,000	104	100
				Sept. 1873	[3]45	(2)					
08106310	San Gabriel River near Rockdale	1,359	1974-	July 27, 1979	32.91	15,600	21	35.63	[1]33,000	24.3	100
08110430	Big Creek near Freestone	57.1	1950-	May 17, 1989	15.37	5,950	21	16.31	[1]9,400	165	100
				Apr. 1957	[3]19	(2)					
08110500	Navasota River near Easterley	968	1845-	May 2, 1944	27.13	60,300	22	27.15	[1]61,000	63.0	50
				June 1899	[3]29	[6]90,000					
08111000	Navasota River near Bryan	1,454	1840-	Apr. 29, 1966	16.57	38,200	23	17.97	[1]75,000	51.6	100
				June 1899	[3]19.5	(2)					
08116650	Brazos River at Rosharon	45,339	1884-	May 14, 1968	50.74	79,900	Jan. 3	51.85	85,000	1.87	20
				Dec. 11, 1913	[7]56.4	(2)					
	COLORADO RIVER BASIN										
08158700	Onion Creek near Driftwood	124	1958-	June 6,1985	16.38	8,990	Dec. 22	16.5	(2)	(2)	(2)
08158810	Bear Creek below Farm Road 1826, near Driftwood	12.2	1915-	June 11, 1981	13.05	8,330	22	14.2	(2)	(2)	(2)
				June 9, 1939	[3]16.2	(2)					
				1915	[3]18.2	(2)					
08158920	Williamson Creek at Oak Hill	6.30	1974-	June 11, 1981	8.55	4,170	22	10.69	(2)	(2)	(2)
08159000	Onion Creek at U.S. Highway 183, near Austin	321	1869-	May 28, 1929	30.5	76,000	21	30.50	(2)	(2)	(2)
				July 3, 1869	[8]38	(2)					
				Sept. 9, 1921	[9]38.0	(2)					
08159200	Colorado River at Bastrop	[10]39,979	1845-	Oct. 29, 1960	34.45	79,600	22	37.42	(2)	(2)	(2)
				June 7 or 8, 1864	[3]60.3	(2)					
08160400	Colorado River above LaGrange	40,874	1969-	May 19, 1989	13.47	19,500	23	43.38	(2)	(2)	(2)
				July 9, 1869	[11]56.7	(2)					

[1] Estimated.

[2] Not determined.

[3] Based on information provided by local residents.

[4] Recurrence interval greater than 100 years. Value shown is approximate ratio of discharge to that of the 100-year flood.

[5] 9,566 mi^2 probably is non-contributing.

[6] From rating curve extended above 60,000 ft^3/s.

[7] Based on information provided by the Texas State Department of Highways and Public Transportation.

[8] Based on newspaper accounts.

[9] From floodmark.

[10] 11,403 mi^2 probably is non-contributing.

[11] From marble high-water marker in LaGrange, Texas.

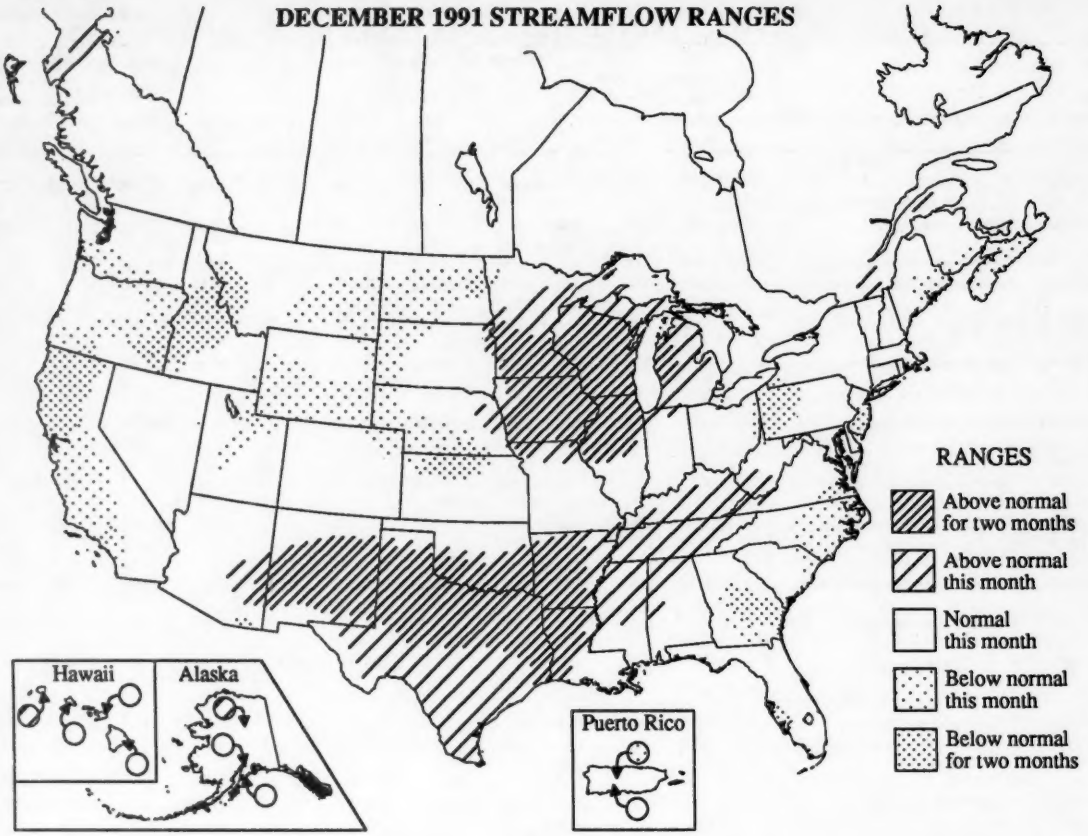
Provisional data; subject to revision

FLOOD DATA FOR SELECTED RESERVOIRS IN TEXAS, DECEMBER 1991

WRD Station number	Reservoir and location	Drainage area (square miles)	Period of known floods	Maximum flood previously known: Date	Stage (feet)	Contents (acre-feet)	Maximum during present flood: Date	Stage (feet)	Contents (acre-feet)
	BRAZOS RIVER BASIN								
08095550	Waco Lake at Waco	1,652	1965-	May 15, 1968	470.86	292,100	31	[1]488.48	[1]521,000
08104050	Stillhouse Hollow Lake near Belton	1,313	1966-	May 2, 1977	637.26	347,100	31	[1]648.62	[1]447,100
08109900	Somerville Lake near Somerville	1,007	1966-	June 9, 1979	248.55	311,000	31	[1]248.94	[1]317,900
	COLORADO RIVER BASIN								
08143000	Lake Brownwood near Brownwood	1,265	1944-	Apr. 26, 1990	1,432.65	210,000	21	1,432.60	209,500
08148000	Lake Buchanan near Bumet	31,910	1937-	Jan. 24, 1968	1,020.8	1,010,000	20	1,021.39	942,700
08154500	Lake Travis near Austin	38,755	1940-	May 18, 1957	707.4	1,770,000	25	710.44	1,852,000

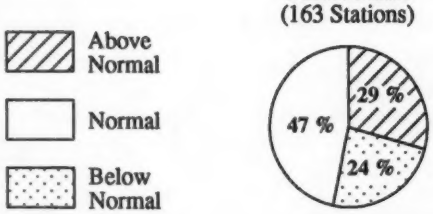
[1] Provided by U.S. Army Corps of Engineers.

DECEMBER 1991 STREAMFLOW RANGES

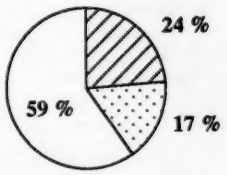


SUMMARY OF DECEMBER 1991 STREAMFLOW FLOW RANGES

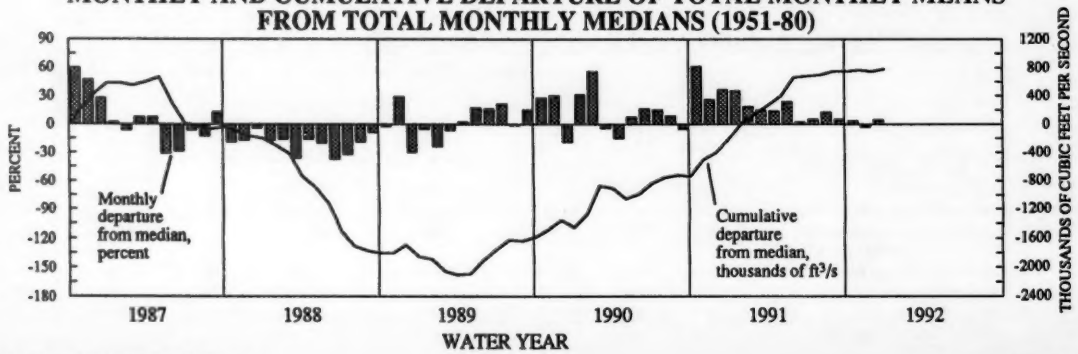
By Conditions at Individual Index Stations



By Total Area
Conterminous United States and southern Canada
(Area=3,771,000 mi^2 – revised)



MONTHLY AND CUMULATIVE DEPARTURE OF TOTAL MONTHLY MEANS FROM TOTAL MONTHLY MEDIANS (1951-80)



and southern Canada was 3 percent above median, after a 34 percent increase from last month, and 23 percent less than flow during December 1990.

Nine new December extremes—lows in North Dakota and Puerto Rico, highs in Quebec, Tennessee, Michigan, Wisconsin, Oklahoma, and two in Texas—occurred at streamflow index stations (see table on page 8), compared with two lows and two highs during November. Hydrographs for the nine stations at which new extremes occurred are on pages 8-9.

The combined flow of the 3 largest rivers in the lower 48 States—Mississippi, St. Lawrence, and Columbia—averaged 1,171,000 ft^3/s; 40 percent above median and in the above-normal range, after a 68 percent increase in flow (attributable to a 78 percent increase in flow of the Mississippi River) from November to December when flow was in the normal range. Flow of the St. Lawrence River was in the normal range for the seventh consecutive month. Flow of the Mississippi River was in the above-normal range after a normal range November. Flow of the Columbia River was in the below-normal range for the fourth consecutive month. Hydrographs for both the combined and individual flows of the "Big 3" are on page 10. Dissolved solids and water temperatures at four large river stations are also given on page 10. Flow data for the "Big 3" and 42 other large rivers are given in the Flow of Large Rivers table on page 11.

Month-end index reservoir contents were in the below-average range (below the month-end average for the period of record by more than 5 percent of normal maximum contents) at 29 of 100 reporting sites, compared with 32 of 99 at the end of November, and 35 of 100 at the end of December 1990, including most reservoirs in Maryland, Nebraska, North Dakota, Montana, Idaho, Wyoming, Utah, Nevada, and California. Contents were in the above-average range at 44 reservoirs (compared with 37 last month), including most reservoirs in Nova Scotia, Maine, New Hampshire, Vermont, Massachusetts, South Carolina, Georgia, Alabama, the Tennessee Valley, Wisconsin, Oklahoma, Texas, Arizona, and New Mexico. Reservoirs with contents in the below-average range and significantly lower than last year (with normal maximum contents of at least 1,000,000 acre-feet) are: the New York City Reservoir System, New York; Hungry Horse, Montana; Boise River, Idaho; and Clair Engle Lake and Shasta Lake, California. Four reservoirs had less than 10 percent of normal maximum contents (December average in parentheses): John Martin, Colorado, 8 percent (18); Pine Flat, California 8 percent (47); Lake Tahoe, California-Nevada, 0 percent (46); and Rye Patch, Nevada, 1 percent (50). Graphs of contents for seven reservoirs are shown on page 12 with contents for the 100 reporting reservoirs given on page 13. Maps on page 15 show reservoir storage conditions for December 1991 and December 1990 on the streamflow maps for those months.

Mean December elevations at four master gages on the Great Lakes (provisional National Ocean Service data) were in the normal range and above median on Lake Superior, in the normal range and below median on Lake Huron and Lake Erie, and in the below-normal range on Lake Ontario. Levels rose from those for November on all the lakes except Lake Superior. December levels ranged from 0.01 foot lower (Lake Superior) to 0.17 foot higher (Lake Huron) than those for November. Monthly means have now been in the normal range for 3 months on Lake Superior, 19 months on Lake Huron, and 9 months on Lake Erie . Monthly means have been in the below-normal range on Lake Ontario for the last four months. December 1991 levels ranged from 0.86 foot lower (Lake Ontario) to 0.45 foot higher (Lake Superior) than those for December 1990. Stage hydrographs for the master gages on Lake Superior, Lake Huron, Lake Erie, and Lake Ontario are on page 14.

Utah's Great Salt Lake (graph on page 14) rose 0.10 foot December 15-31, ending the month at 4,201.70 feet above National Geodetic Vertical Datum. Lake level was 0.70 foot lower than at the end of December 1990, and 10.15 feet lower than the maximum of record which occurred in June 1986 and March-April 1987.

Maps on page 15 show streamflow conditions for December 1991 and December 1990. December 1991 has about 4 percent more area in the above-normal range, about 37 percent less area in the below-normal range, and about 18 percent more area in the normal range than December 1990. The distribution of area in the flow ranges is also dissimilar for the two months. Below-normal range streamflow occurred during both months in parts of Washington, Oregon, California, Nevada, Utah, Idaho, Montana, Wyoming, Colorado, the Dakotas, Nebraska, Kansas, Minnesota, New Jersey, Virginia, Georgia, and Florida. Above-normal range streamflow occurred during both months in parts of Quebec, Vermont, Michigan, Wisconsin, Illinois, Ohio, West Virginia, Virginia, Kentucky, Missouri, Arkansas, Tennessee, Alabama, Mississippi, Louisiana, New Mexico, and Arizona. Both maps also show reservoir storage at all index reservoir stations for comparison with streamflow.

Graphs for 12 hydrologic areas show monthly percent departure of streamflow from median for the 1987-92 water years (page 16) and also compare monthly streamflow for the 1991 and 1992 water years with median monthly streamflow for 1951-80 (page 17). Streamflow was below median in the Hudson Bay, Atlantic Slope, Ohio River, the Great and other closed, Pacific Slope, and Columbia River basins, and above median in the other 6 basins. Streamflow decreased from that for November in the Hudson Bay, St. Lawrence River, Upper Mississippi River, Missouri River, and also the Great and other closed basins, and increased in the other 7 basins.

Maps on page 18 show streamflow conditions for fall (October-December) 1991 and fall 1990. Fall 1991 has about 15 percent less area in the above-normal range, about 22 percent less area in the below-normal range, and about 14 percent more area in the normal range than fall 1990. Below-normal range streamflow occurred in the fall of both years in parts of California, Oregon, Nevada, Utah, Idaho, Montana, Wyoming, Arizona, Colorado, North Dakota, Nebraska, Kansas, New Jersey, Virginia, Georgia, and Florida. Above-normal range streamflow occurred during both months in parts of Quebec, Vermont, Michigan, Wisconsin, Illinois, Tennessee, Alabama, Arkansas, Mississippi, Louisiana, and New Mexico.

Maps on page 19 show streamflow conditions for calendar year 1991 and calendar year 1990. Calendar year 1991 has

Provisional data; subject to revision

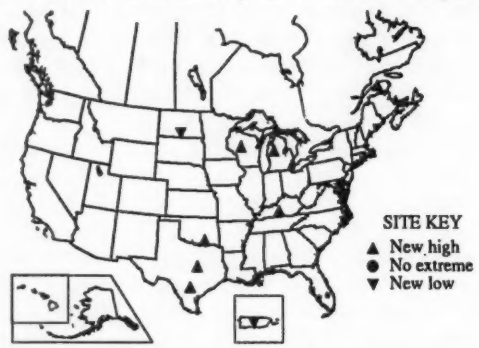
NEW EXTREMES DURING DECEMBER 1991 AT STREAMFLOW INDEX STATION

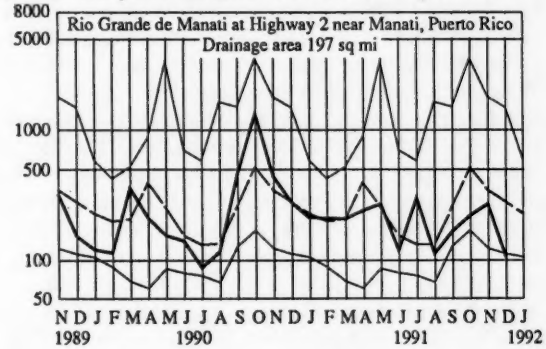
Station number	Stream and place of determination	Drainage area (square miles)	Previous December extremes (period of record) Years of record	Monthly mean in cfs (year)	Daily mean in cfs (year)	December 1991 Monthly mean in cfs	Percent of median	Daily mean in cfs	Day
			LOW FLOWS						
06354000	Cannonball River at Breien, North Dakota	4,100	57	0.38 (1934)	0 (1)	0.05	0	0	16
50038100	Rio Grande De Manati at Highway 2 near Manati, Puerto Rico	197	21	111 (1978)	92.0 (1978)	106	37	82.0	19
			HIGH FLOWS						
02160100	Matane River near Matane, Quebec, Canada	.636	65	2,390 (1950)	6,300 (1973)	2,890	435	...	...
03604500	Buffalo River near Lobelville, Tennessee	707	64	4,619 (1972)	24,700 (1969)	4,805	379	31,800	3
04121500	Muskegon River at Evart, Michigan	1,450	59	1,942 (1982)	4,260 (1966)	2,250	253	3,380	14
05362000	Jump River at Sheldon, Wisconsin	576	76	751 (1965)	3,270 (1965)	1,100	785	...	...
07331000	Washita River near Dickson, Oklahoma	7,202	63	5,009 (1987)	30,800 (1946)	9,305	2,591	44,400	21
08095000	North Bosque River near Clifton, Texas	968	68	996 (1971)	10,400 (1971)	4,675	20,238	59,200	20
08167500	Guadalupe River near Spring Branch, Texas	1,315	69	1,708 (1986)	6,530 (1986)	4,413	2,521	51,500	21

[1]Occurred more than once.

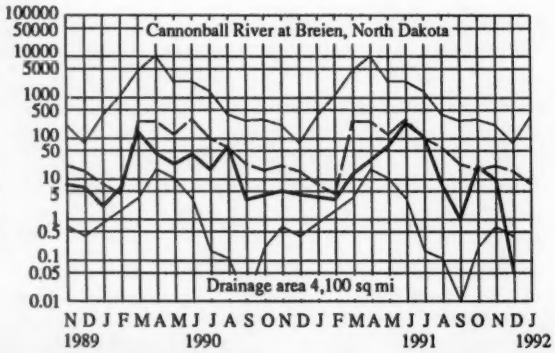
MONTHLY MEAN DISCHARGE OF SELECTED STREAMS

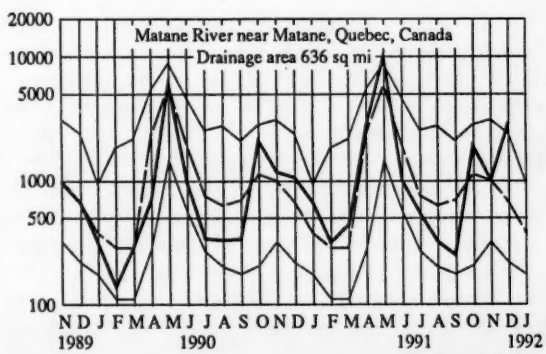
Area between light-weight solid lines indicates range between highest and lowest record for the month. Dashed line indicates median of monthly values for reference period, 1951-80. Heavy line indicates mean for current period.




Rio Grande de Manati at Highway 2 near Manati, Puerto Rico
Drainage area 197 sq mi
8000
5000
1000
500
100
50
N D J F M A M J J A S O N D J F M A M J J A S O N D J
1989
1990
1991
1992

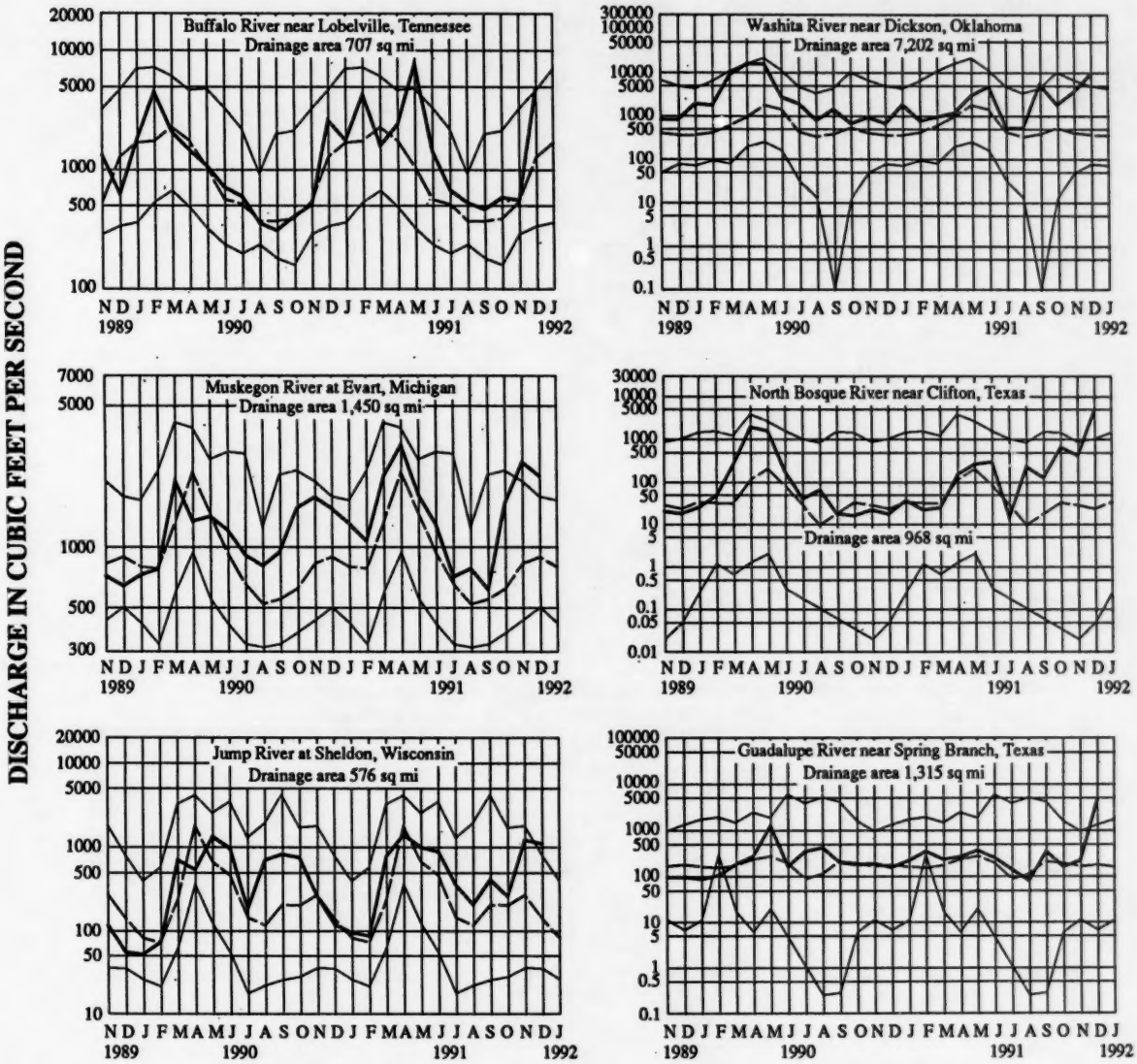
DISCHARGE IN CUBIC FEET PER SECOND





MONTHLY MEAN DISCHARGE OF SELECTED STREAMS

Area between light-weight solid lines indicates range between highest and lowest record for the month. Dashed line indicates median of monthly values for reference period, 1951-80. Heavy line indicates mean for current period.


DISCHARGE IN CUBIC FEET PER SECOND
Buffalo River near Lobelville, Tennessee
Drainage area 707 sq mi
Washita River near Dickson, Oklahoma
Drainage area 7,202 sq mi
Muskegon River at Evart, Michigan
Drainage area 1,450 sq mi
North Bosque River near Clifton, Texas
Drainage area 968 sq mi
Jump River at Sheldon, Wisconsin
Drainage area 576 sq mi
Guadalupe River near Spring Branch, Texas
Drainage area 1,315 sq mi
N D J F M A M J J A S O N D J F M A M J J A S O N D J
1989
1990
1991
1992

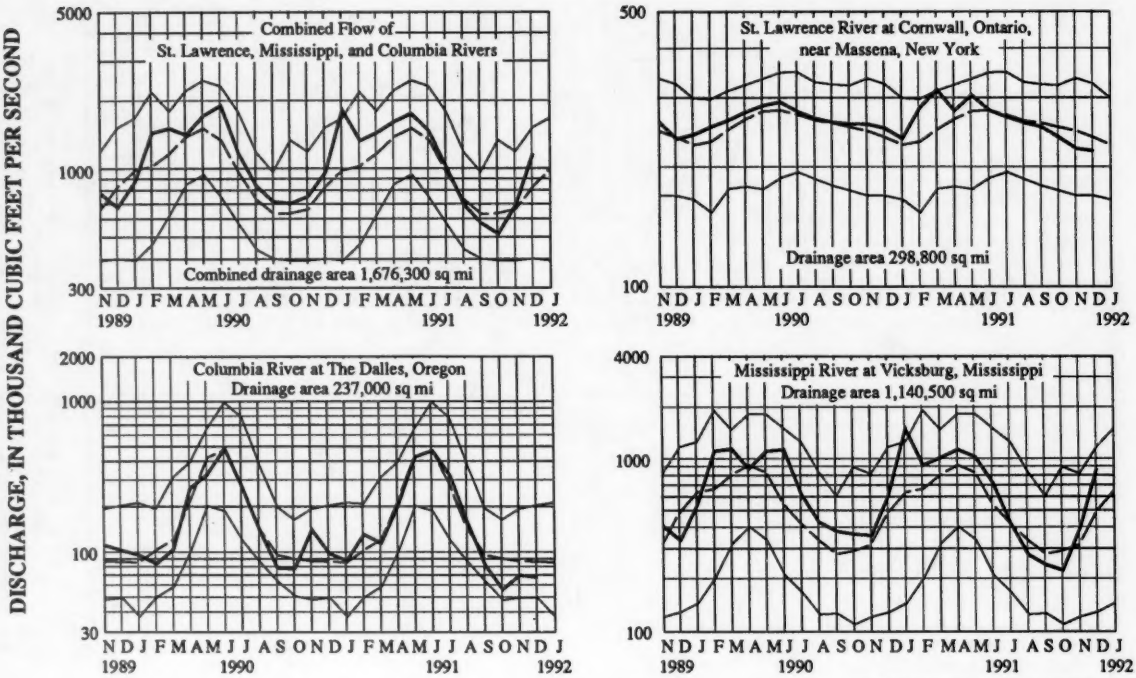
about 30 percent less area in the above-normal range, about 19 percent less area in the below-normal range, and about 24 percent more area in the normal range than calendar year 1990. Below-normal range streamflow occurred for both years in parts of Washington, Oregon, California, Nevada, Arizona, Utah, Idaho, Montana, Wyoming, Colorado, the Dakotas, Kansas, Minnesota, Ontario, and Quebec. Above-normal range streamflow occurred during both months in parts of Quebec, Vermont, Minnesota, Iowa, Oklahoma, Arkansas, Tennessee, South Carolina, Georgia, Alabama, Mississippi, Louisiana, Texas, Alberta, and British Columbia.

Streamflow was in the normal to above-normal range at 71 percent of the 192 index stations in the United States, southern Canada, and Puerto Rico for calendar year 1991, compared with 79 percent of stations in those ranges for calendar year 1990.

For calendar 1991, the combined flow of the 3 largest rivers in the lower 48 States—Mississippi, St. Lawrence, and Columbia—averaged 1,184,000 ft^3/s; 18 percent above median and in the above-normal range. Flows of the St. Lawrence River (2 percent above median) and the Columbia River (3 percent below median) were in the normal range, for the third and second consecutive years, respectively. Flow of the Mississippi River was 31 percent above median and in the above-normal range for the third consecutive year.

HYDROGRAPHS FOR THE "BIG THREE" RIVERS

Area between light-weight solid lines indicates range between highest and lowest record for the month. Dashed line indicates median of monthly values for reference period, 1951-80. Heavy line indicates mean for current period.


DISCHARGE, IN THOUSAND CUBIC FEET PER SECOND
Combined Flow of St. Lawrence, Mississippi, and Columbia Rivers
Combined drainage area 1,676,300 sq mi
St. Lawrence River at Cornwall, Ontario, near Massena, New York
Drainage area 298,800 sq mi
Columbia River at The Dalles, Oregon
Drainage area 237,000 sq mi
Mississippi River at Vicksburg, Mississippi
Drainage area 1,140,500 sq mi
N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J
1989
1990
1991
1992

Provisional data; subject to revision

DISSOLVED SOLIDS AND WATER TEMPERATURES, FOR DECEMBER 1991, AT DOWNSTREAM SITES ON FIVE LARGE RIVERS

Station number	Station name	December data of following calendar years	Stream discharge during month	Dissolved-solids concentration[1]		Dissolved-solids discharge[1]			Water temperature[2]		
			Mean (cfs)	Minimum (mg/L)	Maximum (mg/L)	Mean	Minimum (tons per day)	Maximum	Mean in °C	Minimum in °C	Maximum in °C
01463500	Delaware River at Trenton, New Jersey, (Morrisville, Pennsylvania)	1991	9,554	85	112	2,476	1,461	5,127	4.0	0.5	8.0
		1944-90	13,040	62	138	[3]3,375	463	13,440	[3]3.5	0	12.0
		(Extreme yr)		(1983)	(1980)		(1963)	(1989)			
			[4]11,650								
07289000	Mississippi River at Vicksburg, Mississippi	1991	[5]934,071	[5]177	[5]218	[5]491,386	[5]475,357	[5]503,569	[5]8.5	[5]7.0	[5]10.0
		1975-90	704,400	153	343	399,100	130,500	712,800	8.0	0	14.0
		(Extreme yr)		(1978)	(1988)		(1988)	(1985)			
			[4]495,500								
03612500	Ohio River at lock and dam 53, near Grand Chain, Illinois, (streamflow station at Metropolis, Illinois)	1991	465,500	184	304	...	98,800	661,000	...	7.5	12.5
		1954-90	328,400	138	362	...	21,300	469,000	...	0	14.0
		(Extreme yr)		(1962)	(1969)		(1980)	(1977)			
			[4]286,000								
06934500	Missouri River at Hermann, Missouri. (60 miles west of St. Louis, Missouri)	1991	44,990	287	445	45,800	36,100	62,900	7.5	4.0	15.0
		1975-90	71,440	222	770	70,900	18,000	237,000	3.5	0	14.0
		(Extreme yr)		(1982)	(1978)		(1989)	(1982)			
			[4]40,520								
14128910	Columbia River at Warrendale, Oregon (streamflow station at The Dalles, Oregon)	1991	144,700	...	...	...	...	...	...	...	...
		1975-90	157,900	82	128	45,500	22,800	77,300	6.5	0.5	10.5
		(Extreme yr)		(1975)	(1984)		(1978)	(1980)			
			[4]87,500								

[1]Dissolved-solids concentrations, when not analyzed directly, are calculated on basis of measurements of specific conductance.
[2]To convert °C to °F: [(1.8 x °C) + 32] = °F.
[3]Mean for 8-year period (1983-90).
[4]Median of monthly values for 30-year reference period, water years 1951-80, for comparison with data for current month.
[5]Values are for the 14-day period December 18-31.

Provisional data; subject to revision

FLOW OF LARGE RIVERS DURING DECEMBER 1991

Station number	Stream and place of determination	Drainage area (square miles)	Average discharge through September 1985 (cubic feet per second)	December 1991					
				Monthly mean discharge (cubic feet per second)	Percent of median monthly discharge 1951–80	Change in discharge from previous month (percent)	Discharge near end of month		
							Cubic feet per second	Million gallons per day	Date
01014000	St. John River below Fish River at Fort Kent, Maine	5,665	9,758	4,577	93	–49	4,300	2,780	31
01318500	Hudson River at Hadley, New York	1,664	2,908	2,620	106	39	2,320	1,500	31
01357500	Mohawk River at Cohoes, New York	3,456	5,683	5,490	91	31	6,720	4,340	31
01463500	Delaware River at Trenton, New Jersey	6,780	11,670	9,554	82	59	...	...	...
01570500	Susquehanna River at Harrisburg, Pennsylvania	24,100	34,340	22,400	66	128	14,000	9,000	30
01646500	Potomac River near Washington, District of Columbia	11,560	[1]11,500	[1]5,480	55	175	...	...	...
02105500	Cape Fear River at William O. Huske Lock, near Tarheel, North Carolina.	4,852	5,002	† 1,699	44	9	...	...	...
02131000	Pee Dee River at Peedee, South Carolina	8,830	9,871	† 4,849	65	23	7,120	4,600	31
02226000	Altamaha River at Doctortown, Georgia	13,600	13,730	† 4,463	56	35	4,140	2,680	29
02320500	Suwannee River at Branford, Florida	7,880	6,986	3,486	109	–17	3,330	2,150	31
02358000	Apalachicola River at Chattahoochee, Florida	17,200	22,420	14,870	87	39	15,100	9,760	31
02467000	Tombigbee River at Demopolis lock and dam, near Coatopa, Alabama.	15,385	23,520	* 39,800	195	522	31	20	...
02489500	Pearl River near Bogalusa, Louisiana	6,573	9,880	9,997	182	120	4,780	3,090	31
03049500	Allegheny River at Natrona, Pennsylvania	11,410	[1]19,580	† [1]10,520	40	216	7,410	4,790	30
03085000	Monongahela River at Braddock, Pennsylvania	7,337	[1]12,480	† [1]6,940	47	64	14,400	9,310	30
03193000	Kanawha River at Kanawha Falls, West Virginia	8,367	12,550	* 18,180	132	284	14,300	9,240	29
03234500	Scioto River at Higby, Ohio	5,131	4,583	1,344	33	88	1,250	807	31
03294500	Ohio River at Louisville, Kentucky[2#]	91,170	115,800	160,900	124	304	104,000	67,000	29
03377500	Wabash River at Mount Carmel, Illinois	28,635	27,660	16,320	71	26	12,800	8,270	31
03469000	French Broad River below Douglas Dam, Tennessee[3#]	4,543	[1]6,739	[1]9,150	140	180	...	...	...
04084500	Fox River at Rapide Croche Dam, near Wrightstown, Wisconsin.[2]	6,010	4,238	* 6,770	188	–3	5,580	3,600	31
04264331	St. Lawrence River at Cornwall, Ontario, near Massena, New York.[4#]	298,800	243,900	221,000	92	–1	220,000	142,000	31
02NG001	St. Maurice River at Grand Mere, Quebec	16,300	24,910	10,400	78	–44	19,700	12,700	31
05082500	Red River of the North at Grand Forks, North Dakota	30,100	2,593	† 465	40	–1	427	275	31
05133500	Rainy River at Manitou Rapids, Minnesota	19,400	12,920	9,000	92	–18	8,500	5,490	27
05330000	Minnesota River near Jordan, Minnesota	16,200	3,680	* 4,795	735	–8	3,600	2,330	31
05331000	Mississippi River at St. Paul, Minnesota[#]	36,800	[1]11,020	* 13,070	269	–6	11,200	7,240	31
05365500	Chippewa River at Chippewa Falls, Wisconsin	5,650	5,149	* 7,814	248	–52	5,900	3,810	31
05407000	Wisconsin River at Muscoda, Wisconsin	10,400	8,710	* 10,000	154	–9	9,000	5,800	31
05446500	Rock River near Joslin, Illinois	9,549	6,080	* 12,000	256	66	7,870	5,090	31
05474500	Mississippi River at Keokuk, Iowa[#]	119,000	63,790	* 103,100	283	14	93,900	60,700	31
06214500	Yellowstone River at Billings, Montana	11,795	7,056	† 2,660	88	–32	2,300	1,490	31
06934500	Missouri River at Hermann, Missouri[#]	524,200	80,880	44,990	111	28	41,200	26,600	31
07289000	Mississippi River at Vicksburg, Mississippi[5#]	1,140,500	584,000	* 881,000	178	120	...	...	...
07331000	Washita River near Dickson, Oklahoma	7,202	1,402	* 9,305	2,592	160	6,750	4,360	29
08276500	Rio Grande below Taos Junction Bridge, near Taos, New Mexico.	9,730	742	501	117	2	480	310	31
09315000	Green River at Green River, Utah	44,850	6,391	2,390	100	–12	...	...	...
11425500	Sacramento River at Verona, California	21,251	19,430	† 8,102	39	23	...	...	...
13269000	Snake River at Weiser, Idaho	69,200	18,520	† 11,200	72	–3	11,000	7,100	31
13317000	Salmon River at White Bird, Idaho	13,550	11,390	† 3,730	81	–17	3,460	2,240	31
13342500	Clearwater River at Spalding, Idaho	9,570	15,510	5,140	81	10	3,810	2,460	31
14105700	Columbia River at The Dalles, Oregon[6#]	237,000	[1]193,500	† [1]68,540	78	–3	124,000	80,400	31
14191000	Willamette River at Salem, Oregon	7,280	[1]23,690	[1]36,380	83	29	16,300	10,500	31
15515500	Tanana River at Nenana, Alaska	25,600	23,810	* 7,811	116	–20	7,400	4,780	31
08MF005	Fraser River at Hope, British Columbia	83,800	96,250	39,550	90	–10	36,400	23,500	31

#Indicates stations excluded from the combination bar/line graph. See Explanation of Data.

* Above-normal range

† Below-normal range

[1]Adjusted.

[2]Records furnished by Corps of Engineers.

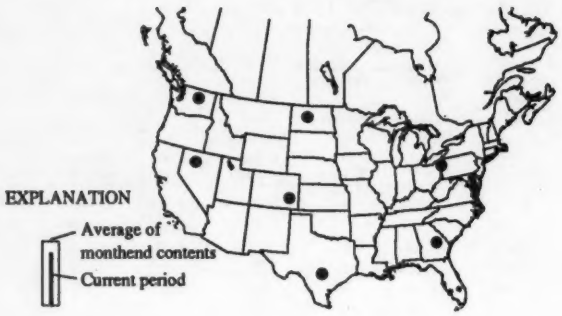
[3]Records furnished by Tennessee Valley Authority.

[4]Records furnished by Buffalo District, Corps of Engineers, through International St. Lawrence River Board of Control. Discharges shown are considered to be the same as discharge at Ogdensburg, N.Y., when adjusted for storage in Lake St. Lawrence.

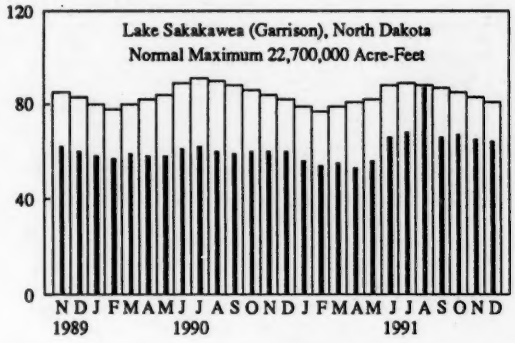
[5]Records of daily discharge computed jointly by Corps of Engineers and Geological Survey.

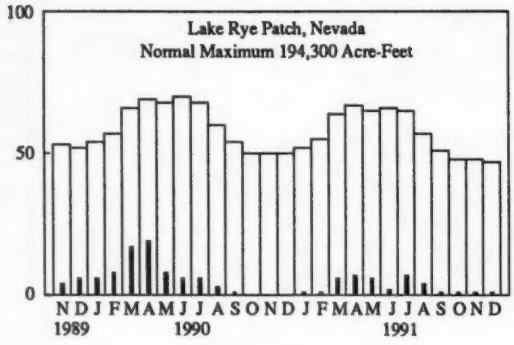
[6]Discharge determined from information furnished by Bureau of Reclamation, Corps of Engineers, and Geological Survey.

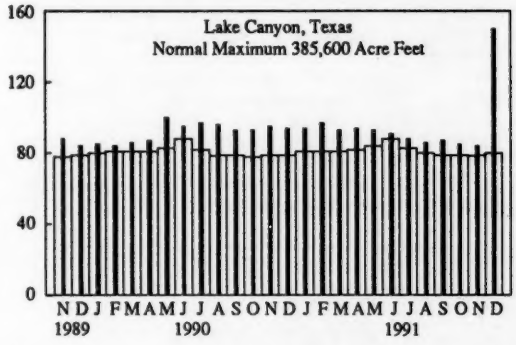
USABLE CONTENTS OF SELECTED RESERVOIRS AND RESERVOIR SYSTEMS

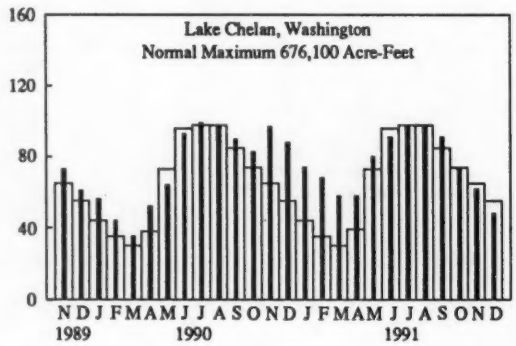


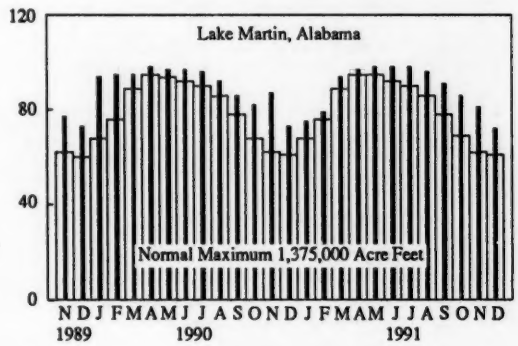
PERCENT OF NORMAL MAXIMUM

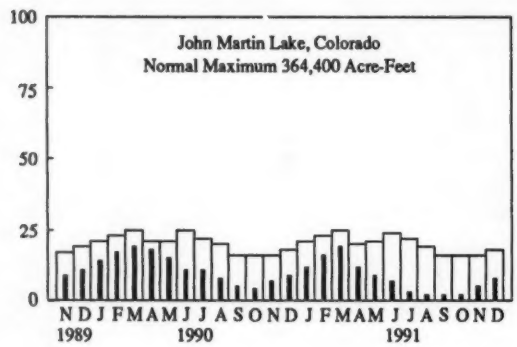

Lake Sakakawea (Garrison), North Dakota
Normal Maximum 22,700,000 Acre-Feet
120
80
40
0
N D J F M A M J J A S O N D J F M A M J J A S O N D
1989
1990
1991

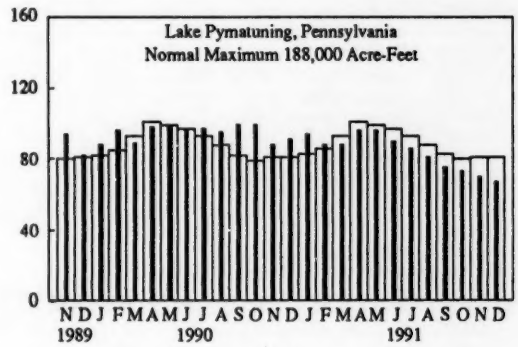












Provisional data; subject to revision

USABLE CONTENTS OF SELECTED RESERVOIRS AND RESERVOIR SYSTEMS NEAR END OF DECEMBER 1991

[Contents are expressed in percent of reservoir or reservoir system capacity. The usable capacity of reservoir or reservoir system is shown in the column headed "Normal maximum"]

Reservoir or reservoir system Principal uses: F-Flood control I-Irrigation M-Municipal P-Power R-Recreation W-Industrial	Percent of normal maximum: End of December 1991	End of December 1990	Average for end of December	End of November 1991	Normal maximum (acre-feet)[1]
NOVA SCOTIA					
Rossignol, Mulgrave, Falls Lake, St. Margaret's Bay, Black, and Ponhook Reservoirs (P)	* 56	62	50	56	[2]226,300
QUEBEC					
Allard (P)	* 90	32	58	91	280,600
Gouin (P)	67	86	66	68	6,954,000
MAINE					
Seven Reservoir Systems (MP)	* 71	84	57	71	4,107,000
NEW HAMPSHIRE					
First Connecticut Lake (P)	* 74	77	58	74	76,450
Lake Francis (FPR)	* 77	93	70	88	99,310
Lake Winnipesaukee (PR)	* 76	88	62	78	165,700
VERMONT					
Harriman (P)	* 68	77	60	74	116,200
Somerset (P)	* 83	79	68	83	57,390
MASSACHUSETTS					
Cobble Mountain and Borden Brook (MP)	* 78	91	72	75	77,920
NEW YORK					
Great Sacandaga Lake (FPR)	57	80	53	51	786,700
Indian Lake (FMP)	58	78	61	59	103,300
New York City Reservoir System (MW)	† 57	92	78	51	1,680,000
NEW JERSEY					
Wanaque (M)	70	90	72	49	85,100
PENNSYLVANIA					
Allegheny (FPR)	28	39	33	15	1,180,000
Pymatuning (FMR)	† 67	91	81	70	188,000
Raystown Lake (FR)	60	67	58	62	761,900
Lake Wallenpaupack (PR)	62	72	57	49	157,800
MARYLAND					
Baltimore Municipal System (M)	† 70	94	83	68	261,900
NORTH CAROLINA					
Bridgewater (Lake James) (P)	* 91	95	78	90	288,800
Narrows (Badin Lake) (P)	91	94	93	91	128,900
High Rock Lake (P)	† 42	80	60	57	234,800
SOUTH CAROLINA					
Lake Murray (P)	* 76	66	62	73	1,614,000
Lakes Marion and Moultrie (P)	* 69	61	61	75	1,777,000
SOUTH CAROLINA-GEORGIA					
Strom Thurmond Lake (FP)	* 64	55	52	62	1,730,000
GEORGIA					
Burton (PR)	* 69	83	55	70	104,000
Sinclair (MPR)	* 88	86	76	89	214,000
Lake Sidney Lanier (FMPR)	50	42	49	47	1,686,000
ALABAMA					
Lake Martin (P)	* 72	73	61	81	1,375,000
TENNESSEE VALLEY					
Clinch Projects: Norris and Melton Hill Lakes (FPR)	* 43	52	32	39	2,293,000
Douglas Lake (FPR)	13	20	11	21	1,395,000
Hiwassee Projects: Chatuge, Nottely, Hiwassee, Apalachia, Blue Ridge, Ocoee 3, and Parksville Lakes (FPR)	* 49	54	39	55	1,012,000
Holston Projects: South Holston, Watauga, Boone, Fort Patrick Henry, and Cherokee Lakes (FPR)	* 48	52	33	48	2,880,000
Little Tennessee Projects: Nantahala, Thorpe, Fontana, and Chilhowee Lakes (FPR)	* 56	41	38	57	1,478,000
WISCONSIN					
Chippewa and Flambeau (PR)	* 75	81	64	98	365,000
Wisconsin River (21 Reservoirs) (PR)	* 81	78	55	88	399,000
MINNESOTA					
Mississippi River Headwater System (FMR)	28	28	23	33	1,640,000
NORTH DAKOTA					
Lake Sakakawea (Garrison) (FIPR)	† 64	60	81	65	22,700,000
SOUTH DAKOTA					
Angostura (I)	73	42	68	71	130,770
Belle Fourche (I)	† 25	24	43	17	185,200
Lake Francis Case (FIP)	58	57	59	51	4,589,000
Lake Oahe (FIP)	61	55	64	60	22,240,000
Lake Sharpe (FIP)	102	103	98	101	1,697,000
Lewis and Clark Lake (FIP)	96	95	100	96	432,000
NEBRASKA					
Lake McConaughy (IP)	† 52	52	70	50	1,948,000
OKLAHOMA					
Eufaula (FPR)	* 120	96	88	102	2,378,000
Keystone (FPR)	* 107	81	91	89	661,000
Tenkiller Ferry (FPR)	* 114	103	95	111	628,200
Lake Altus (FIMR)	* 69	58	49	55	133,000
Lake O'The Cherokees (FPR)	* 94	92	81	87	1,492,000
OKLAHOMA-TEXAS					
Lake Texoma (FMPRW)	* 146	95	90	102	2,722,000
TEXAS					
Bridgeport (IMW)	* 103	85	49	96	386,400
Canyon (FMR)	* 150	94	80	84	385,600
International Amistad (FIMPW)	* 103	94	85	102	3,497,000
International Falcon (FIMPW)	* 105	78	77	103	2,668,000
Livingston (IMW)	* 106	101	89	105	1,788,000
Possum Kingdom (IMPRW)	91	91	95	94	570,200
Red Bluff (P)	* 38	22	30	28	307,000
Toledo Bend (P)	83	87	84	75	4,472,000
Twin Buttes (FIM)	* 44	49	34	38	177,800
Lake Kemp (IMW)	* 108	91	84	100	268,000
Lake Meredith (FMW)	38	32	37	38	796,900
Lake Travis (FIMPRW)	* 150	91	79	90	1,144,000
MONTANA					
Canyon Ferry (FIMPR)	† 77	77	84	78	2,043,000
Fort Peck (FPR)	† 62	56	82	63	18,910,000
Hungry Horse (FIPR)	† 61	82	75	70	3,451,000
WASHINGTON					
Ross (PR)	74	83	69	82	1,052,000
Franklin D. Roosevelt Lake (IP)	94	87	92	98	5,022,000
Lake Chelan (PR)	† 48	88	55	62	676,100
Lake Cushman (PR)	74	56	79	77	359,500
Lake Merwin (P)	98	97	96	99	245,600
IDAHO					
Boise River (4 Reservoirs) (FIP)	† 24	36	55	20	1,235,000
Coeur d'Alene Lake (P)	† 35	48	54	46	238,500
Pend Oreille Lake (FP)	† 33	37	47	34	1,561,000
IDAHO-WYOMING					
Upper Snake River (8 Reservoirs) (MP)	57	46	59	38	4,401,000
WYOMING					
Boysen (FIP)	78	73	75	83	802,000
Buffalo Bill (IP)	† 59	38	66	60	421,300
Keyhole (P)	† 15	15	41	15	193,800
Pathfinder, Seminoe, Alcova, Kortes, Glendo, and Guernsey Reservoirs (I)	† 36	32	48	34	3,056,000
COLORADO					
John Martin (FIR)	† 8	9	18	5	364,400
Taylor Park (IR)	* 71	73	55	18	106,200
Colorado-Big Thompson Project (I)	54	47	57	54	730,300
COLORADO RIVER STORAGE PROJECT					
Lake Powell; Flaming Gorge, Fontenelle, Navajo, and Blue Mesa Reservoirs (IFPR)	† 63	66	72	64	31,620,000
UTAH-IDAHO					
Bear Lake (IPR)	† 32	33	58	...	1,421,000
CALIFORNIA					
Folsom (FIMPR)	† 36	15	54	40	1,000,000
Hetch Hetchy (MP)	* 46	19	37	52	360,400
Isabella (FIR)	† 15	8	26	16	568,100
Pine Flat (FIR)	† 8	4	47	8	1,001,000
Clair Engle Lake (Lewiston) (FP)	† 22	39	73	22	2,438,000
Lake Almanor (P)	* 66	65	50	65	1,036,000
Lake Berryessa (FIMRW)	† 33	37	79	34	1,600,000
Millerton Lake (FI)	† 38	34	54	35	503,200
Shasta Lake (FIPR)	† 29	37	68	30	4,377,000
CALIFORNIA-NEVADA					
Lake Tahoe (IMPRW)	† 0	0	46	0	744,600
NEVADA					
Rye Patch (I)	† 1	0	50	1	194,300
ARIZONA-NEVADA					
Lake Mead and Lake Mohave (FIMP)	75	76	71	74	27,970,000
ARIZONA					
San Carlos (IP)	* 47	6	22	38	935,100
Salt and Verde River System (IMPR)	* 76	39	42	73	2,019,100
NEW MEXICO					
Conchas (FIR)	* 91	59	82	88	315,700
Elephant Butte and Caballo (FIPR)	* 78	63	41	72	2,394,000

[1] 1 acre-foot = 0.04356 million cubic feet = 0.326 million gallons = 0.504 cubic feet per second per day.

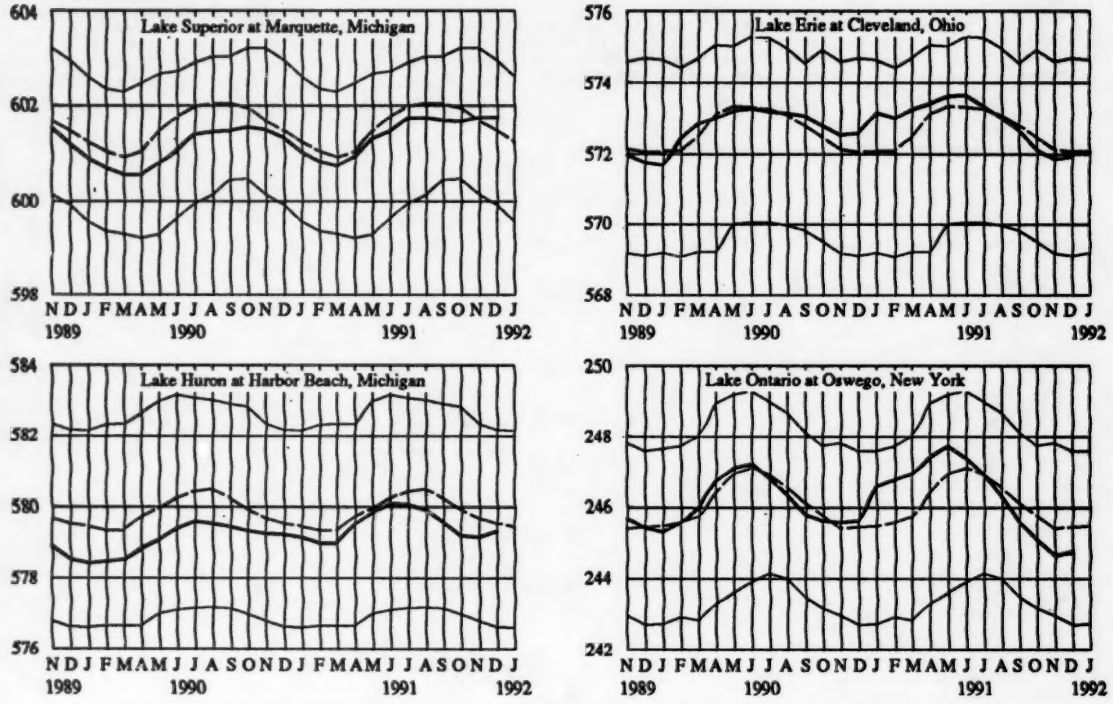
[2] Thousands of kilowatt-hours (the potential electric power that could be generated by the volume of water in storage).

* Above-average range

† Below-average range

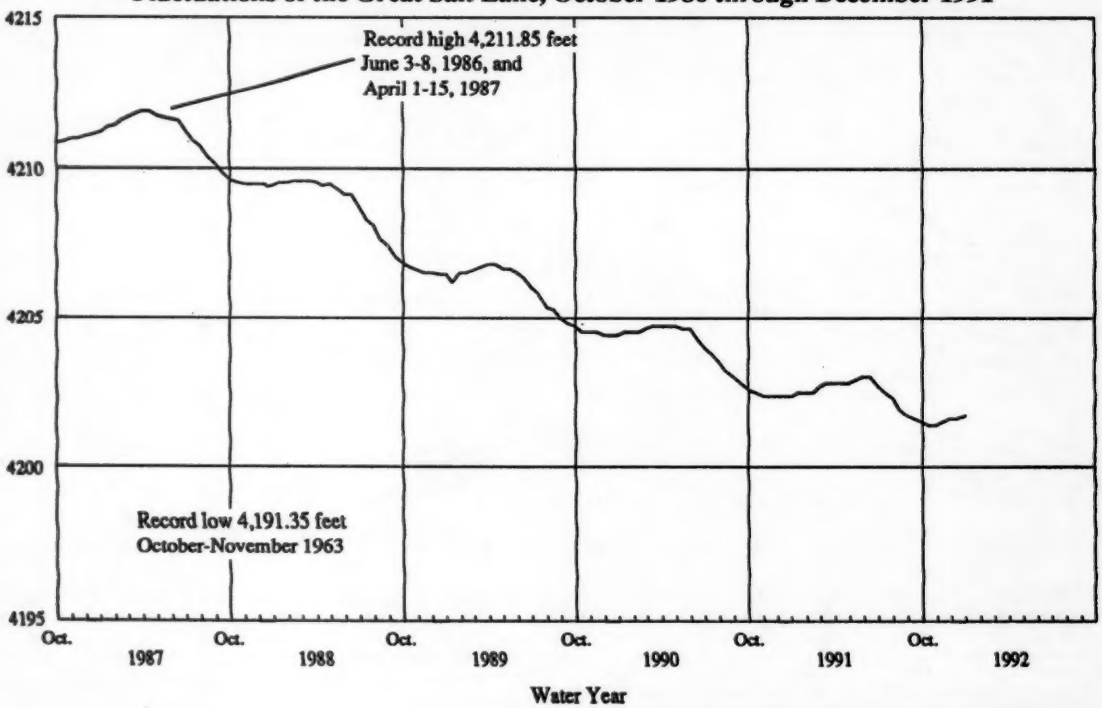
GREAT LAKES ELEVATIONS

Area between light-weight solid lines indicates range between highest and lowest record for the month. Dashed line indicates median of monthly values for reference period, 1951-80. Heavy line indicates mean for current period. Data from National Ocean Service.

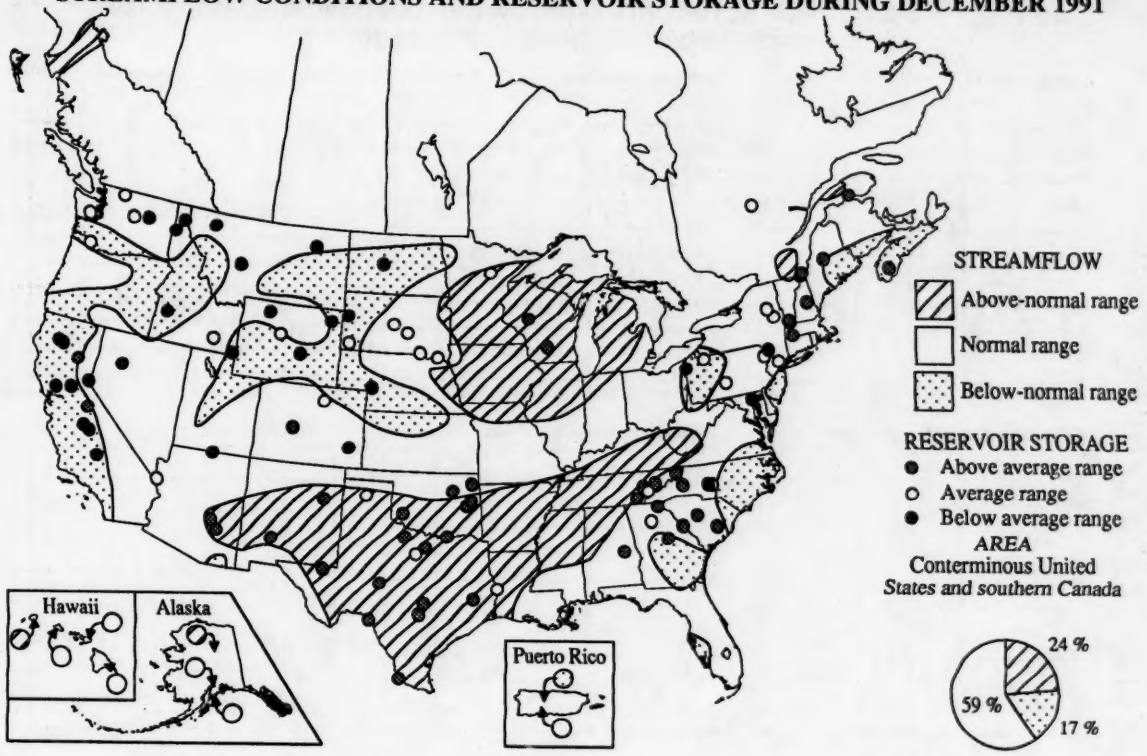


ELEVATION, IN FEET ABOVE NATIONAL GEODETIC VERTICAL DATUM OF 1929

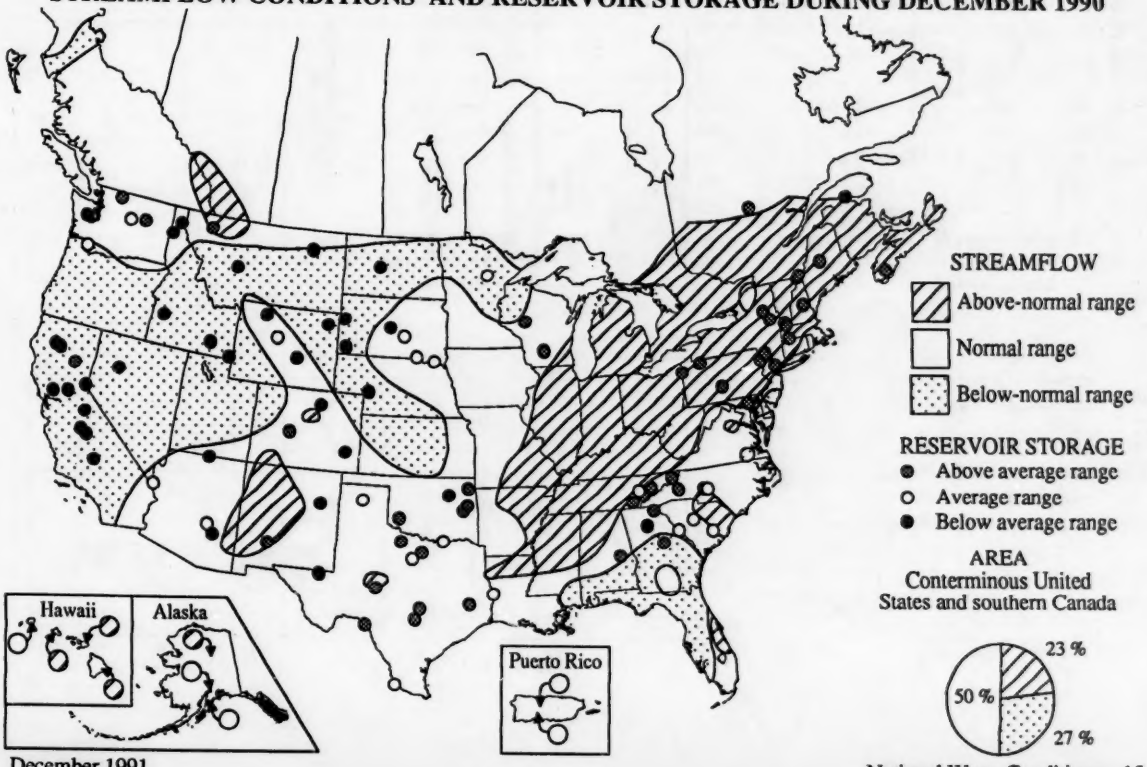
Fluctuations of the Great Salt Lake, October 1986 through December 1991



STREAMFLOW CONDITIONS AND RESERVOIR STORAGE DURING DECEMBER 1991

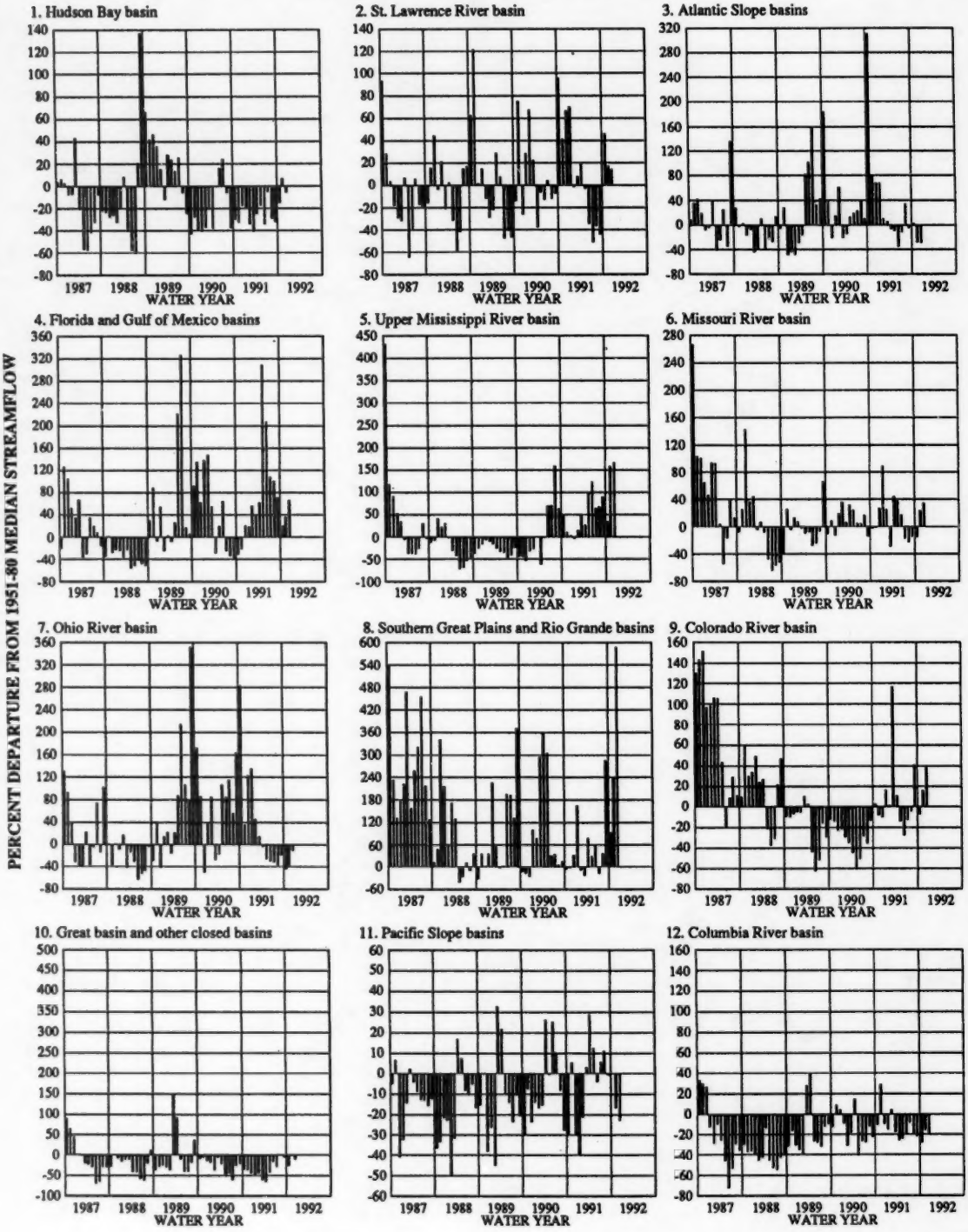


STREAMFLOW CONDITIONS AND RESERVOIR STORAGE DURING DECEMBER 1990

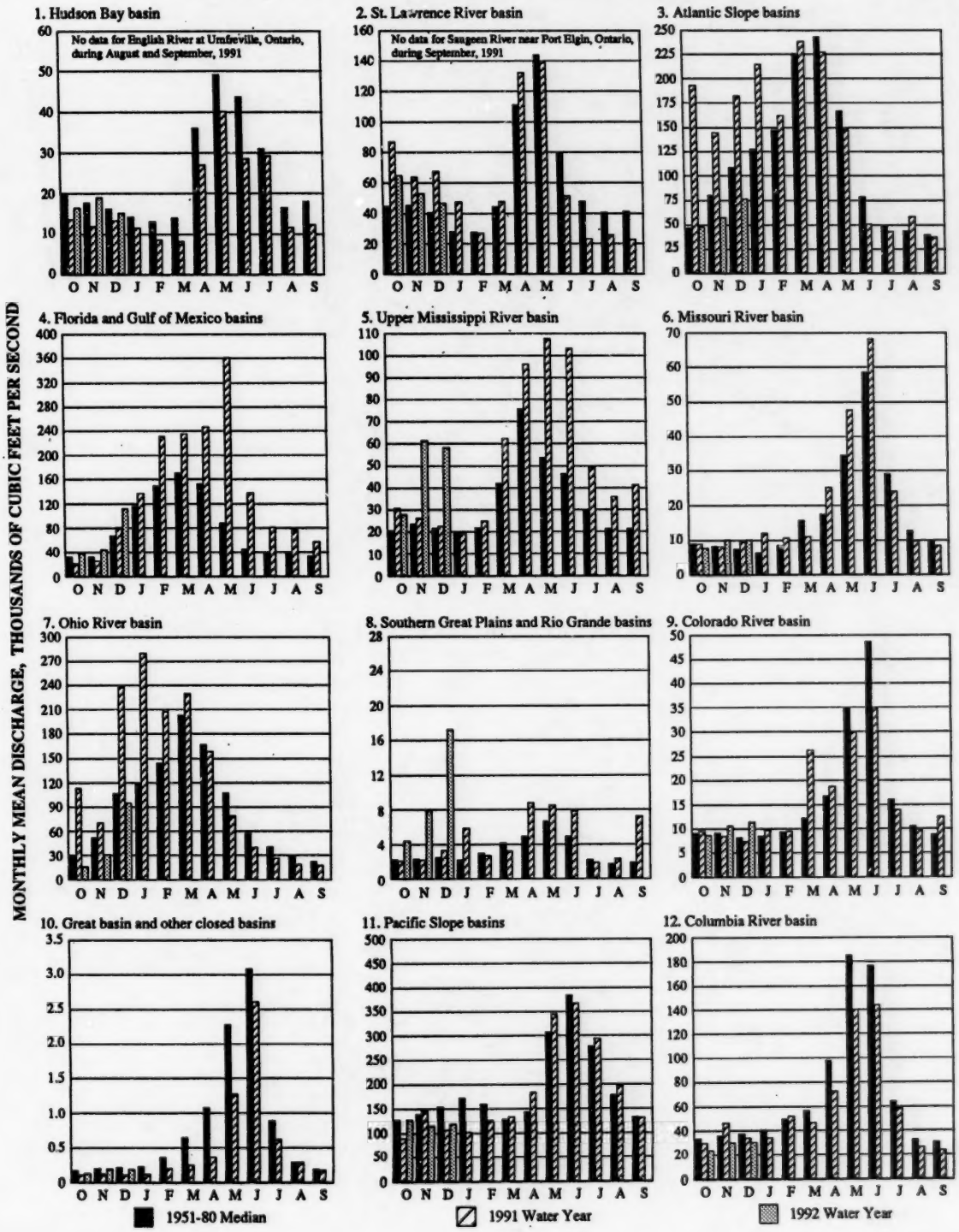


December 1991

MONTHLY DEPARTURE OF ACTUAL STREAMFLOW (OCTOBER 1986-DECEMBER 1991) FROM MEDIAN STREAMFLOW (1951-80)

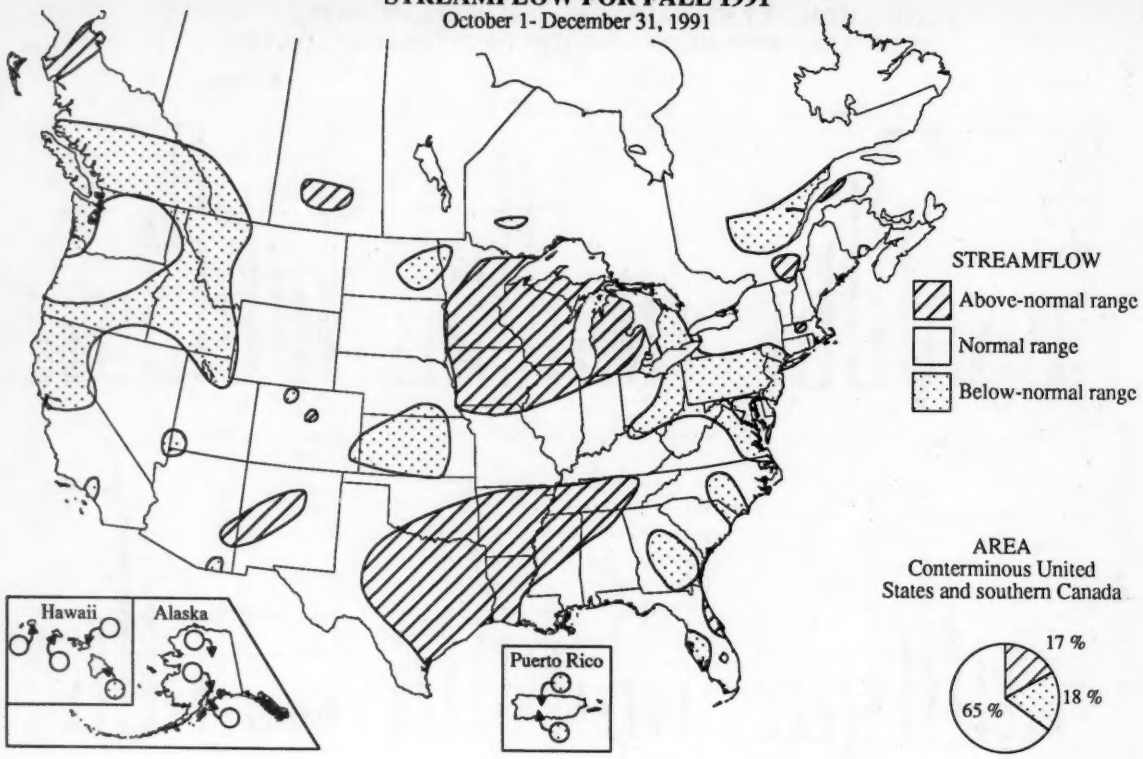

1. Hudson Bay basin
2. St. Lawrence River basin
3. Atlantic Slope basins
4. Florida and Gulf of Mexico basins
5. Upper Mississippi River basin
6. Missouri River basin
7. Ohio River basin
8. Southern Great Plains and Rio Grande basins
9. Colorado River basin
10. Great basin and other closed basins
11. Pacific Slope basins
12. Columbia River basin
PERCENT DEPARTURE FROM 1951-80 MEDIAN STREAMFLOW
WATER YEAR
1987 1988 1989 1990 1991 1992

ACTUAL MONTHLY STREAMFLOW, 1991 AND 1992 WATER YEARS, COMPARED WITH MEDIAN MONTHLY STREAMFLOW, 1951-80


1. Hudson Bay basin
No data for English River at Umfreville, Ontario, during August and September, 1991
2. St. Lawrence River basin
No data for Sangeen River near Port Elgin, Ontario, during September, 1991
3. Atlantic Slope basins
4. Florida and Gulf of Mexico basins
5. Upper Mississippi River basin
6. Missouri River basin
7. Ohio River basin
8. Southern Great Plains and Rio Grande basins
9. Colorado River basin
10. Great basin and other closed basins
11. Pacific Slope basins
12. Columbia River basin
O N D J F M A M J J A S
MONTHLY MEAN DISCHARGE, THOUSANDS OF CUBIC FEET PER SECOND
1951-80 Median
1991 Water Year
1992 Water Year

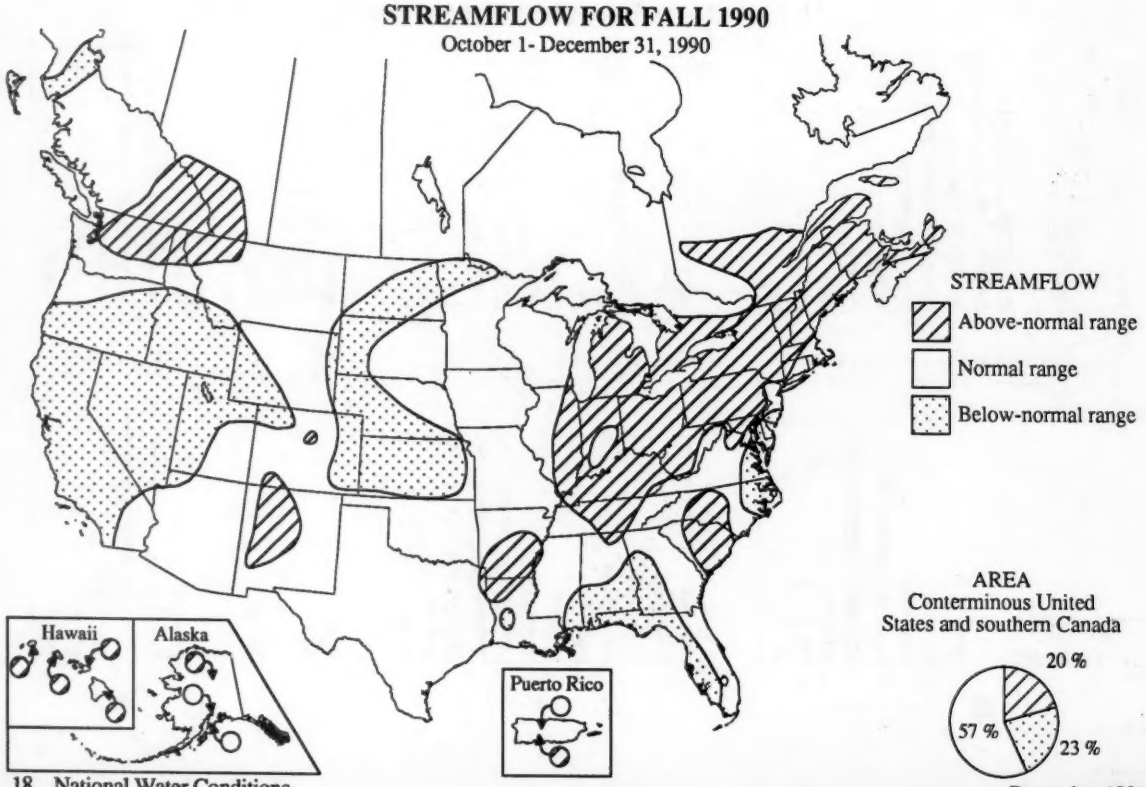
STREAMFLOW FOR FALL 1991

October 1- December 31, 1991

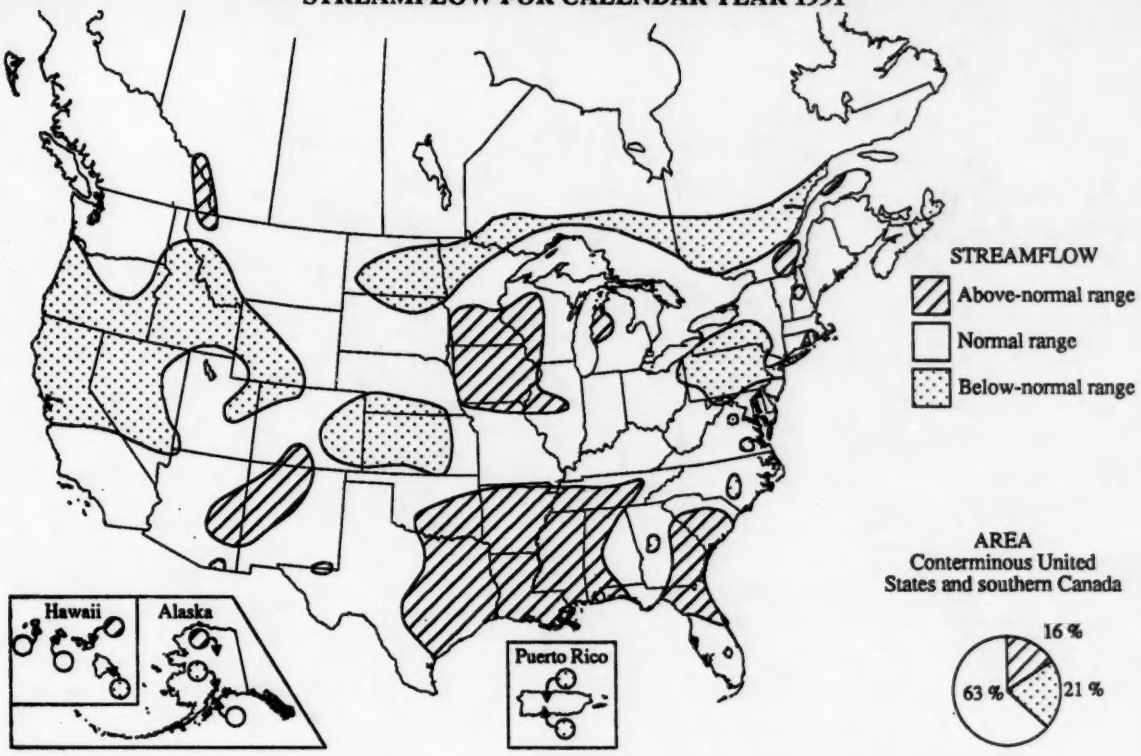


STREAMFLOW FOR FALL 1990

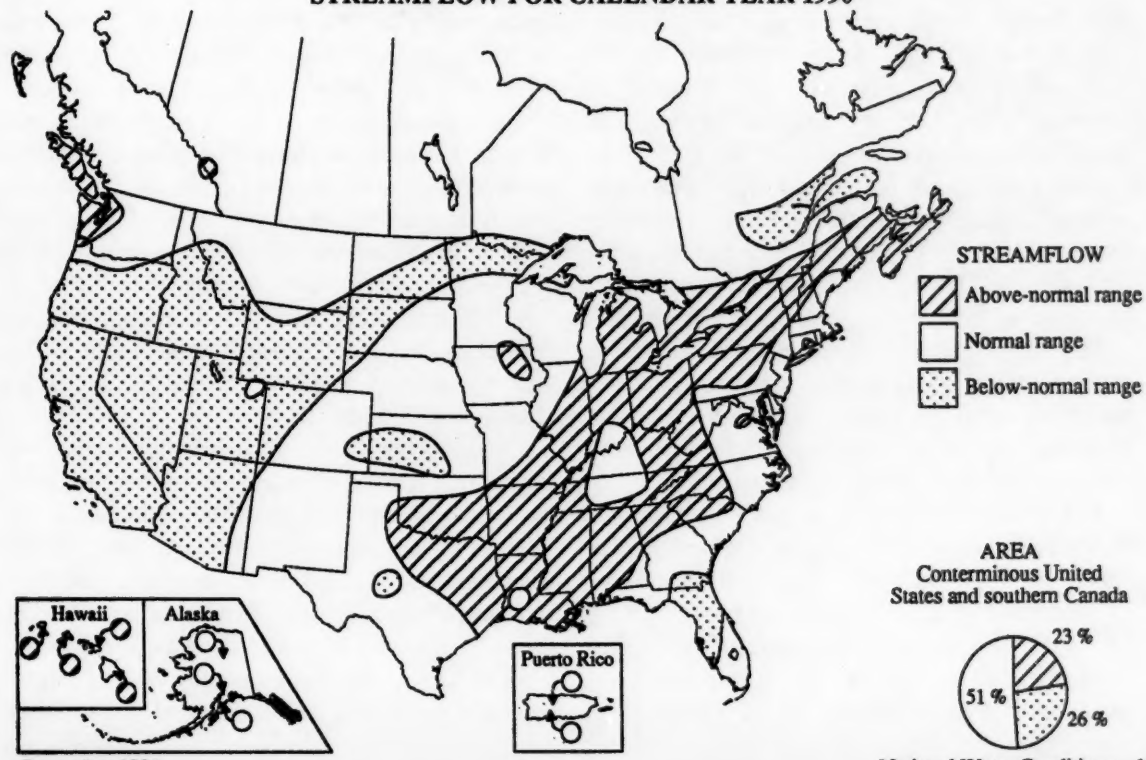
October 1- December 31, 1990



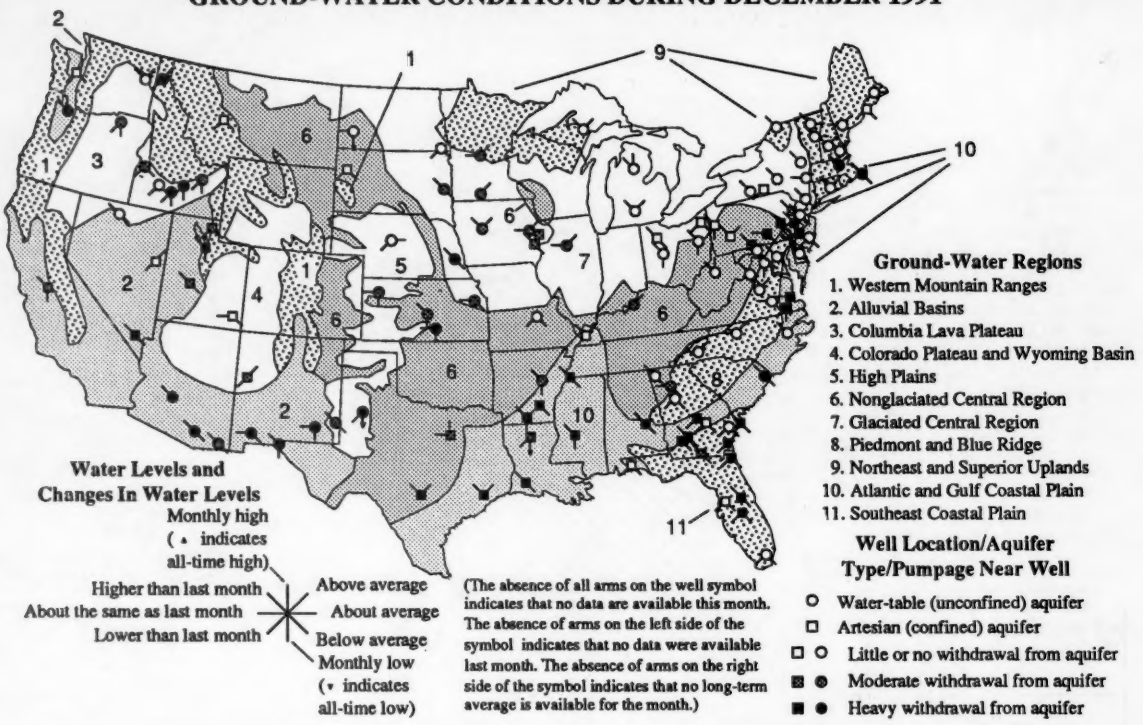
STREAMFLOW FOR CALENDAR YEAR 1991



STREAMFLOW FOR CALENDAR YEAR 1990



GROUND-WATER CONDITIONS DURING DECEMBER 1991


Ground-Water Regions
1. Western Mountain Ranges
2. Alluvial Basins
3. Columbia Lava Plateau
4. Colorado Plateau and Wyoming Basin
5. High Plains
6. Nonglaciated Central Region
7. Glaciated Central Region
8. Piedmont and Blue Ridge
9. Northeast and Superior Uplands
10. Atlantic and Gulf Coastal Plain
11. Southeast Coastal Plain
Water Levels and Changes In Water Levels
Monthly high (▲ indicates all-time high)
Higher than last month
About the same as last month
Lower than last month
Above average
About average
Below average
Monthly low (▼ indicates all-time low)
(The absence of all arms on the well symbol indicates that no data are available this month. The absence of arms on the left side of the symbol indicates that no data were available last month. The absence of arms on the right side of the symbol indicates that no long-term average is available for the month.)
Well Location/Aquifer Type/Pumpage Near Well
Water-table (unconfined) aquifer
Artesian (confined) aquifer
Little or no withdrawal from aquifer
Moderate withdrawal from aquifer
Heavy withdrawal from aquifer

New extremes occurred at 28 ground-water index stations (see table on page 22) during December-24 lows (including 4 all-time) and 4 highs—compared with 34 new extremes last month. Graphs showing water levels at seven stations for the past 26 months are on page 23. The graphs on page 23 are for wells in the Western Mountain Ranges region in Washington, the Alluvial Basins region in Utah, the High Plains region in New Mexico, the Atlantic and Gulf Coastal Plain region in Texas, the Glaciated Central region in Ohio, the Southeast Coastal Plain region in Georgia, and the Northeast and Superior Uplands region in Vermont.

Ground-water levels in the Western Mountain Ranges region were above last month's levels in Washington and below last month's levels in Idaho and Montana. Levels were above long-term averages in Washington and Idaho and below average in Montana.

In the Alluvial Basins region, ground-water levels were at or above last month's levels except in Washington and parts of Nevada and Utah. Levels were above long-term average in Oregon and part of Nevada, and below long-term averages elsewhere in the Region. December lows occurred in wells in California, Utah (see graph on page 23), New Mexico, and Texas. Level rose to a December high in the well in Oregon.

In the Columbia Lava Plateau region, ground-water levels were below last month's levels and below long-term averages throughout the Region. December lows occurred in three wells in Idaho and one in Oregon.

Ground-water levels in the Colorado Plateau and Wyoming Basin region were at or below last month's levels throughout the Region. Levels were below long-term average in Utah and above average in New Mexico.

In the High Plains region, ground-water levels were at or below last month's levels except in New Mexico. Levels were at or below long-term averages throughout the Region. A December low occurred in the well in Kansas and an all-time low occurred in the Ogallala aquifer near Lubbock, Texas.

Ground-water levels in the Nonglaciated Central region were at or above last month's levels throughout the Region except in South Dakota, Missouri, and Kentucky where levels were below last month's. Levels were above long-term averages in Texas, Kentucky, and West Virginia, mixed in Pennsylvania, and below average elsewhere. December lows occurred in two wells in Kansas, and an all-time low occurred in the Sentinel Butte aquifer near Dickinson, North Dakota.

Provisional data; subject to revision

WATER LEVELS IN KEY OBSERVATION WELLS IN SOME REPRESENTATIVE AQUIFERS IN THE CONTERMINOUS UNITED STATES–DECEMBER 1991

GROUND–WATER REGION Aquifer and Location	Aquifer type and local aquifer pumpage	Depth of well in feet	Water level in feet below land–surface datum	Departure from average in feet	Net change in water level in feet since: Last month	Net change in water level in feet since: Last year	Year records began	Remarks
WESTERN MOUNTAIN RANGES (1)								
Rathdrum Prairie aquifer near Athol, northern Idaho	●	485	459.9	1.9	–1.1	2.3	1929	
ALLUVIAL BASINS (2)								
Alluvial valley fill aquifer in Steptoe Valley, Nevada	□	122	8.89	3.37	–.28	–.61	1949	
Valley fill aquifer, Elfrida area near Douglas, Arizona	●	124	102.51	–19.72	.17	–1.65	1947	
Hueco bolson aquifer at El Paso, Texas	●	640	271.91	–21.08	.54	–1.01	1964	Dec. low
COLUMBIA LAVA PLATEAU (3)								
Snake River Plain aquifer near Eden, Idaho	●	208	128.2	–10.0	–1.9	–4.4	1962	Dec. low
Columbia River basalt aquifer, Pendleton, Oregon		1,501	221.57	–32.81	–1.29	–3.02	1965	Dec. low
COLORADO PLATEAU AND WYOMING BASIN (4)								
Dakota aquifer near Blanding, Utah	□	140	49.72	–2.87	–.09	–3.34	1960	
HIGH PLAINS (5)								
Ogallala aquifer near Colby, Kansas	●	175	130.98	–11.41	.05	–1.24	1947	Dec. low
Southern High Plains aquifer, Lovington, New Mexico	●	212	59.32	–3.64	.14	.51	1971	
NONGLACIATED CENTRAL REGION (6)								
Sentinel Butte aquifer near Dickinson, North Dakota	○	160	21.74	–3.13	–.07	–.63	1968	All–time low
Sand and gravel Pleistocene aquifer near Valley Center, Kansas	●	54	21.10	–3.65	–.07	–1.00	1937	Dec. low
Glacial outwash sand and gravel aquifer near Louisville, Kentucky	●	94	17.66	7.03	–.13	.35	1945	
Upper Pennsylvanian aquifer in the Central Appalachians Plateau near Glenville, West Virginia	○	25	12.50	4.17	.54	2.97	1953	Dec. high
GLACIATED CENTRAL REGION (7)								
Fluvial sand and gravel aquifer, Platte River Valley, near Ashland, Nebraska	●	12	7.70	–1.52	.92	–.14	1933	
Sheyenne Delta aquifer near Wyndmere, North Dakota	○	40	8.38	–2.27	–.21	.42	1963	
Pleistocene (glacial drift) aquifer at Princeton in northern Illinois	●	29	5.90	6.29	–.05	.12	1942	Tied Dec. high
Shallow drift aquifer near Roscommon in north–central part of Lower Peninsula, Michigan	○	14	3.36	1.45	.20	1.16	1934	Dec. high
Silurian–Devonian carbonate aquifer near Dola, Ohio	□	51	12.06	–2.96	.27	–5.92	1954	
PIEDMONT AND BLUE RIDGE (8)								
Water–table aquifer in Petersburg Granite, southeastern Piedmont, Colonial Heights, Virginia	○	100	17.62	–1.64	–.01	–1.31	1939	
Weathered granite aquifer, western Piedmont, Mocksville area, North Carolina	○	31	16.88	1.38	.08	–1.26	1981	
Surficial aquifer at Griffin, Georgia	○	30	19.63	–2.57	–.46	1.76	1943	
NORTHEAST AND SUPERIOR UPLANDS (9)								
Pleistocene glacial outwash aquifer, at Camp Ripley, near Little Falls, Minnesota	●	59	14.17	1.09	.05	.68	1949	
Glacial outwash sand aquifer at Oxford, Maine	○	39	8.54	.53	–.01	–.53	1980	
Shallow sand aquifer (glacial deposits), Acton, Massachusetts	●	34	18.63	.68	.97	.25	1965	
Pleistocene sand aquifer near Morrisville, Vermont	○	50	18.64	–.02	1.08	–1.20	1966	
ATLANTIC AND GULF COASTAL PLAIN (10)								
Columbia deposits aquifer near Camden, Delaware	○	11	8.71	–1.75	.27	–.42	1950	
Memphis sand aquifer near Memphis, Tennessee	■	384	106.63	–15.44	.57	.99	1940	
Eutaw aquifer in the City of Montgomery, Alabama	■	270	25.8	–3.5	.7	.7	1952	
Evangeline aquifer at Houston, Texas	■	1,152	295.33	7.09	3.19	16.56	1978	
SOUTHEAST COASTAL PLAIN (11)								
Upper Floridan aquifer on Cockspur Island, Savannah area, Georgia	■	348	33.80	–5.87	.85	3.46	1956	
Upper Floridan aquifer, Jacksonville, Florida	■	905	23.0	–5.4	–.2	3.2	1930	
Biscayne aquifer near Homestead, Florida	○	20	7.47	–.36	–.58	.46	1932	

Monthly highs occurred in wells in Texas and West Virginia.

Ground-water levels in the Glaciated Central region were generally at or above last month's levels except in North Dakota and part of Ohio where levels were below last month's. Levels were at or above long-term averages in wells in Minnesota, Illinois, and Michigan; mixed with respect to average in Iowa; and below average elsewhere. A December high occurred in one well in Michigan. December lows occurred in wells in Iowa, Ohio (see graph on page 23), and Pennsylvania.

Ground-water levels in the Piedmont and Blue Ridge region were at or above last month's levels except in one well in Georgia where level was below last month's.

NEW EXTREMES DURING DECEMBER AT GROUND–WATER INDEX STATIONS

WRD Station Identification Number	GROUND–WATER REGION Aquifer and Location	Aquifer type and local aquifer pumpage	Depth of well	End–of–month water level in feet below land surface datum: Previous December Record: Years of record	Previous December Record: Average	Previous December Record: Extreme (year)	December 1991
	LOW WATER LEVELS						
	ALLUVIAL BASINS						
315212106245101	Hueco bolson aquifer at El Paso, Texas	●	640	27	250.83	270.90 (1990)	271.91
324340104231701	Roswell Basin shallow aquifer at Dayton, New Mexico	●	250	40	93.62	122.70 (1990)	123.14
382444121123301	Mehrten aquifer near Wilton, California	■	300	5	131.06	135.95 (1990)	138.04
403803111505301	Basin fill aquifer near Holladay, Utah	■	165	12	63.44	79.67 (1990)	80.70
	COLUMBIA LAVA PLATEAU						
423659114111601	Snake River Plain aquifer near Eden, Idaho	●	208	29	118.2	125.7 (1981)	128.2
424953113412801	Snake River Plain aquifer near Rupert, Idaho	●	194	41	150.3	158.6 (1990)	161.0
432700112470801	Snake River Plain aquifer near Atomic City, Idaho	●	636	42	584.5	587.6 (1981)	587.8
453934118491701	Columbia River basalts aquifer at Pendleton, Oregon	●	1,501	22	188.76	218.55 (1990)	221.57
	HIGH PLAINS						
341010102240801	Ogallala aquifer near Lubbock, Texas	●	202	40	58.28	90.98 (1990)	[1]92.92
392329101040201	Ogallala aquifer near Colby, Kansas	●	175	44	119.57	129.74 (1990)	130.98
	NONGLACIATED CENTRAL REGION						
375039097234201	Sand and gravel Pleistocene aquifer near Valley Center, Kansas	●	54	54	17.45	20.42 (1956)	21.10
375810097324301	Equus aquifer near Halstead, Kansas	●	57	52	22.42	36.00 (1990)	40.13
465755102410701	Sentinel Butte aquifer near Dickinson, North Dakota	○	160	22	18.61	21.11 (1990)	[1]21.74
	GLACIATED CENTRAL REGION						
395118082573300	Glacial drift aquifer near Reese, Ohio	○	53	45	11.52	13.18 (1966)	13.26
403207081293800	Glacial-drift aquifer near Dover, Ohio	○	62	31	9.27	12.51 (1988)	12.62
410538080280801	Sandstone and shale aquifer at Pulaski State Game Land 150 near Pulaski, Pennsylvania	○	105	24	15.86	17.56 (1968)	18.93
415534091251502	Cambrian-Ordovician aquifer at Mt. Vernon, Iowa	■	1,557	4	337.23	338.78 (1990)	341.87
	PIEDMONT AND BLUE RIDGE						
385638077220101	Water-table aquifer at Reston, Virginia	○	205	15	13.88	15.95 (1980)	16.16
	ATLANTIC AND GULF COASTAL PLAIN						
321945090152201	Sparta aquifer system at Jackson, Mississippi	■	852	47	256.20	308.88 (1990)	310.82
322357092341701	Sparta aquifer near Ruston, Louisiana	◐	703	17	224.07	236.70 (1990)	[1]237.55
331438092411901	Sparta aquifer near El Dorado, Arkansas	■	540	36	327.83	351.16 (1990)	370.79
344607091543401	Mississippi Valley alluvial aquifer near Lonoke, Arkansas	●	135	16	106.99	117.34 (1990)	118.33
364059076544901	Middle Potomac aquifer at Franklin, Virginia	●	305	31	164.90	209.94 (1990)	210.52
372506076511703	Upper Potomac aquifer near Toano, Virginia	■	401	5	159.10	162.39 (1990)	[1]163.70
	HIGH WATER LEVELS						
	ALLUVIAL BASINS						
452938122254801	Troutdale aquifer near Portland, Oregon	●	715	28	101.91	90.50 (1988)	87.99
	NONGLACIATED CENTRAL REGION						
324842097102901	Twin Mountains (Trinity) aquifer near Hurst/Fort Worth, Texas	●	667	13	459.30	447.63 (1983)	446.37
385604080495901	Upper Pennsylvanian aquifer near Glenville, West Virginia	○	25	38	16.67	14.77 (1989)	12.50
	GLACIATED CENTRAL REGION						
442722084350701	Shallow drift aquifer near Roscommon, Michigan	○	14	57	4.81	3.70 (1985)	3.36

[1] All–time month–end low.

Levels were below long-term averages in New Jersey, Maryland, and Georgia; above long-term averages in North Carolina; and mixed in Pennsylvania and Virginia. A December low occurred in one well in Virginia.

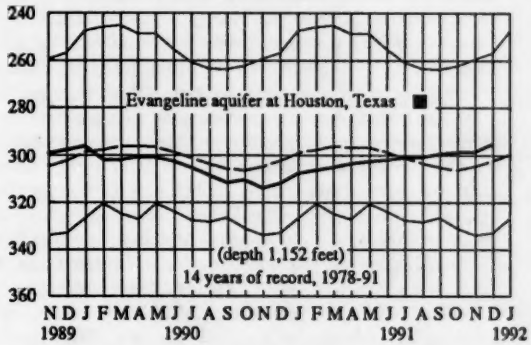
In the Northeast and Superior Uplands region, levels were at or above last month's except in Maine where levels were generally below last month's. Levels were at or above long-term averages throughout the Region except in one well in Maine.

In the Atlantic and Gulf Coastal Plain region, water levels were at or below last month's in Virginia, Georgia, and Florida; mixed in New Jersey, Arkansas, and Louisiana; and above last month's levels elsewhere. Ground-water levels were above long-term averages in North Carolina, Kentucky, and Texas; and at or below average elsewhere. December lows occurred in wells in Virginia, Mississippi, Arkansas, and Louisiana. All-time lows occurred in wells in the Upper Potomac aquifer near Toano, Virginia, and in the Sparta aquifer near Ruston, Louisiana.

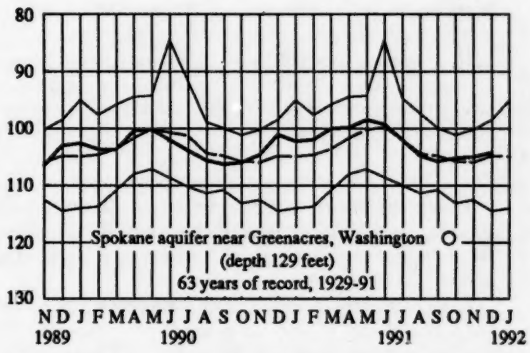
In the Southeast Coastal Plain region, water levels were generally below last month's levels and long-term averages in Florida and mixed with respect to last month's levels and average in Georgia.

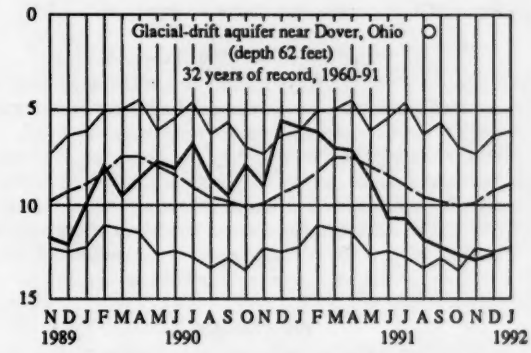
MONTHEND GROUND-WATER LEVELS IN SELECTED WELLS

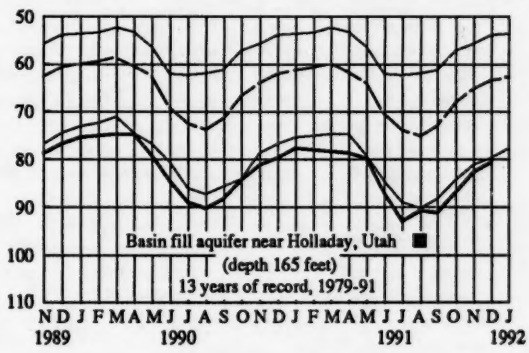
Area between light-weight solid lines indicates range between highest and lowest record for the month. Dashed line indicates average of monthly levels in previous years. Heavy line indicates level for current period.

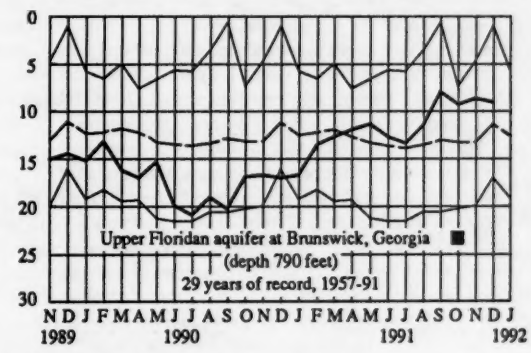


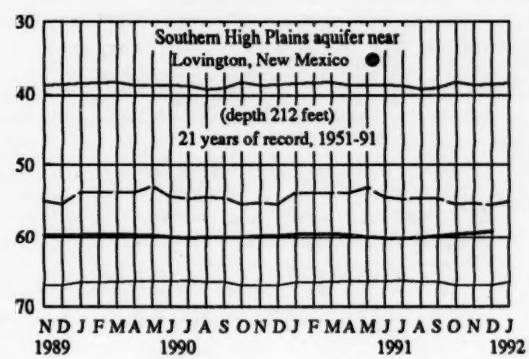
WATER LEVEL, FEET BELOW LAND-SURFACE DATUM

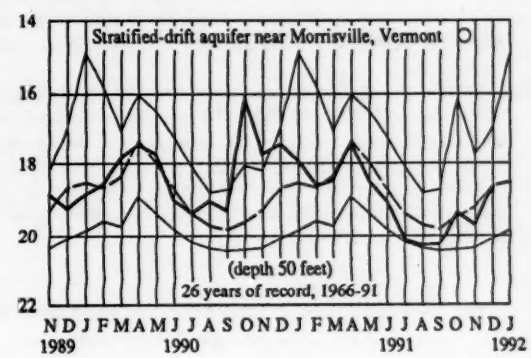



Glacial-drift aquifer near Dover, Ohio
(depth 62 feet)
32 years of record, 1960-91
0
5
10
15
N D J F M A M J J A S O N D J F M A M J J A S O N D J
1989
1990
1991
1992









1991 Weather Review

A mild winter, warm spring, and hot summer contributed to an unusually warm year, though wintry weather struck in late October and early November. Temperatures averaged across the contiguous United States were much above normal, ranking 1991 as the 13th warmest year on record. As in 1990, nearly every part of the country had above-normal temperatures, with many central and eastern locations as much as 3 or 4° F above normal. A month-by-month look at temperatures shows the prevalent warmth, though February and May were especially noteworthy. Only November had outstanding cold. Most of the country measured above-normal precipitation, though a dry summer contributed to a below-normal year in the **Ohio Valley.** Storms in March and December eased **California's** long drought. As a result, much of **Southern California** ended the year with above-normal precipitation. Annual rainfall totals were impressively large in the **lower Mississippi Valley,** exceeding 100 inches at **New Orleans.** Much of the country was wet in the spring and in November and December, with **Texas** flooding the legacy of that State's wettest December ever.

Winter (December 1990 - February 1991)

Despite the severe Western freeze of late December 1990, which damaged **California's** citrus crops and Washington's wheat crop, this was a mild winter, especially **east of the Mississippi.** Portions of the **central Plains** winter wheat region, including much of **Kansas and Nebraska, became** very dry. **California** suffered through an extremely dry winter until the final 2 days of February. Statewide precipitation from October through January was one-fourth of normal, causing hundreds of lakes and reservoirs to reach record-low levels. Stormy, wet weather prevailed from **Texas** northeastward through the Ohio Valley.

Spring (March - May)

Warm, wet, and wild could summarize the spring of 1991. All of the country **east of the Continental Divide** had above-normal temperatures, with **New York City** already reaching 90° F on April 8, the earliest such reading ever. During a late May heat wave, **Baltimore** hit 96° F. More than 35 cities, mainly from **Wisconsin** to the **mid-Atlantic coast,** set records for their hottest May average temperatures.

Spring precipitation exceeded normal over most of the country, **west Texas** being one of the few exceptions. **California's** "March miracle" rains caused most of the State to record spring totals from 150 percent to more than 200 percent of normal. Thunderstorms in April and May ended winter dryness in much of the **Plains** hard red winter wheat region, but excessive wetness hurt soft red wheat **east of the Mississippi. In the East North Central region** of the country, which includes **Iowa,** farmers' fields often turned into ponds. Spring rainfall totals of 12 to 20 inches were the highest in more than 90 years. Incessant rains in the **lower Mississippi Valley** also wreaked havoc with spring planting. Rainfall in **northern Louisiana** and **northern Mississippi** exceeded 35 inches.

Severe weather was widespread this season, with a preliminary spring tornado count of more than 800, which is well over twice the average. On 1 day alone, April 9, over 400 locations from the **South** to the **Northeast** reported large hail or wind damage. On April 26, up to 100 tornadoes took over two dozen lives and caused widespread property damage from **Texas** to **Iowa.** Most of the fatalities came from the storms which struck near **Wichita, KS.**

Summer (June - August)

Hot, dry weather from the **Corn Belt** to the **mid-Atlantic region** shrunk crop yields and dried pastures, though showers were frequent enough to prevent national yields from falling to levels comparable to those of such drought years as 1988 or 1983. The U.S. corn crop's yield of 108.6 bushels per acre was down 8 percent from the year before. Soybean yields of 34.3 bushels per acre set a record. Wheat took the biggest hit of the three major U.S. crops, dropping 13 percent to 34.3 bushels per acre. The freeze in **Washington,** late winter and early spring dryness in the **southern Plains,** and wetness in **eastern winter wheat areas** and the **northern spring wheat areas** all took their toll.

Summer rainfall totaled under 50 percent of normal from **southeast Iowa** eastward to **northwest Ohio. In Illinois, Moline's** total of 3.79 inches was 29 percent of normal and the lowest June-August rainfall since 1886. Heavy rains again pounded the South, as **New Orleans'** year-to-date total exceeded 92 inches by the end of August. This was a new annual record even though the year was only two-thirds complete.

Heat waves affected much of the country. The average summer temperature of 77.8° F in **Philadelphia, PA,** was the highest on record. **Washington, DC,** suffered through 26 days of 95° F heat from May to August, the hottest such period in over a century.

Hurricane Bob brought 100mph gusts to **eastern Long Island** on the afternoon of August 19. Hurtling northward, the storm caused major property damage for **eastern New England** and contributed to a number of rainfall records in **Maine.**

Autumn (September- November)

The country was wet in the interior and dry along both coasts, with temperatures below normal in the **Plains States.** However, the numbers fail to do justice to a season with numerous episodes of dramatic weather.

A late heat wave scorched the **East** during the middle of September, but a sudden shot of cold air swooped down from the **Canadian prairies,** bringing freezing temperatures to the **western Corn Belt.** Crops were sufficiently developed that only late-maturing soybeans were damaged. In October, worsening dryness in the **central Appalachians** and the **Pacific States** contributed to wildfires, while dryness in **Kansas** hurt the new winter wheat crop. As a result of a reversal in the weather pattern, the jet stream delivered unprecedented cold to much of the country from October 28 to November 11. The **northern Plains** felt the brunt of the wintry weather, with high winds, subzero temperatures, and heavy snow. The 28 inches of snow falling from October 31 to November 2 set the all-time record for snow from a single storm in the **Minneapolis-St. Paul** area. By November 4, the severe cold stretched southward to the **Gulf coast** and eastward to **Ohio,** setting over 100 minimum temperature records on that day alone. By November 11, over 640 daily record lows were set or tied throughout the **eastern three-quarters of the country.**

While the arctic outbreak was giving the **Midwest** a strong dose of winter, a major Atlantic storm battered the east coast from **North Carolina** to **Maine** on October 29-November 1. Storm force winds and extremely high tides brought more damage to some areas than Hurricane Bob. Another coastal storm caused additional damage on November 9.

December 1991

Unlike the previous 2 years, there were no major outbreaks of arctic air this December. Nevertheless, the weather was not without drama, as a deluge of rain in the **South Central States** on December 17-22 brought widespread flooding to **eastern Texas.** On a positive note, the unusual wetness erased remaining dryness in **Kansas,** improving winter wheat prospects. Heavy rain and snow on December 27-30 also eased the drought in **California.**

(From *Weekly Weather and Crop Bulletin*, prepared and published by the NOAA/USDA Joint Agricultural Weather Facility)

IS THE DROUGHT OVER?

(From *California Water Supply Outlook*, prepared and published by the California Department of Water Resources)

Two separate storm events during the past two weeks have brightened the previously gloomy water supply outlook. Generous storm amounts in central and southern California have watered parched crop and range lands. But precipitation amounts in the State's primary water producing basins are still far short of average for this date and a long way from levels needed to end the drought. The mountain snowpack is much better than last year, but only slightly over half average for early January.

At the end of December, seasonal precipitation since October 1 was estimated to be 65 percent of average, ranging from over 80 percent in southern hydrologic regions to about 50 percent in the North Coast region. Runoff statewide was 25 percent, compared to about 20 percent last year. If the North Coast region (14 percent) is left out, runoff would average about 1/3 of average. The good news is that many watersheds have been wettened to the point that additional storms, if they occur fairly soon, will begin to produce significant runoff. In fact, the January 4-6 storm did produce small rises in upper Sacramento Valley streams.

Reservoir storage on January 1 was about 12.7 million acre-feet, 57 percent of average, compared to 54 percent 1 year ago. Total storage in the State's 155 major reservoirs actually declined about 0.1 million acre-feet during December; normally it would rise 0.7 million acre-feet. Looking back, total storage on January 1, 1977, was 12.9 million acre-feet, quite similar to this year. (Eventually, storage bottomed out at about 7.5 million acre-feet in early November 1977.)

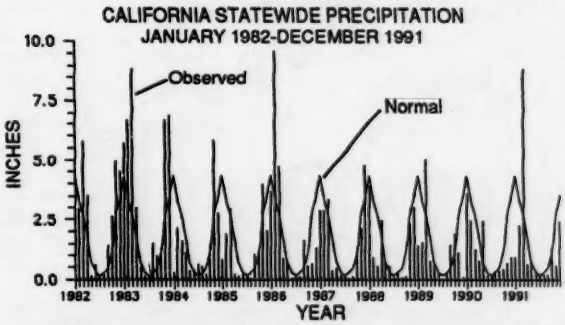
The January 1 forecast of Sacramento River Index runoff for Water Year 1992 (with median precipitation assumed for the rest of the water year) is only 11.3 MAF, 61 percent of average. The possible range is quite large, from about 5 to over 20 MAF, because much of the rainy season is yet to come. For comparison, last year's actual runoff was 8.4 MAF and the lowest of record was 5.1 MAF in 1977.

In view of the perceived wetness of the year-end storms, many ask why the water forecasters remain pessimistic on the runoff outlook. The main reasons: the very low runoff to date, and as of January 8, northern Sierra precipitation was still only about 60 percent of average. It is not likely that the remaining 60 percent of the rainfall season will bring enough to raise the water year to average. However, it is possible; about 15 percent of the years historically have been wet enough to do so after early January. On the other hand, about 25 percent of the years have been dry enough so that Sacramento River runoff would be less than the past season.

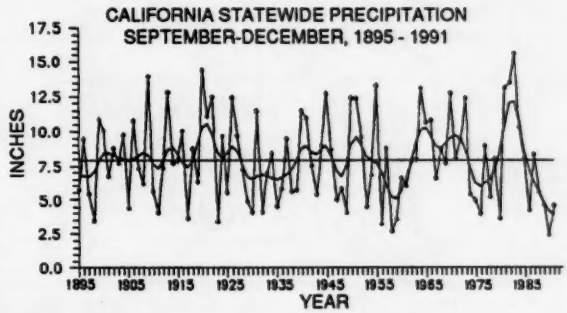
Is the drought over? The hard facts require the answer to be no.

CALIFORNIA PRECIPITATION

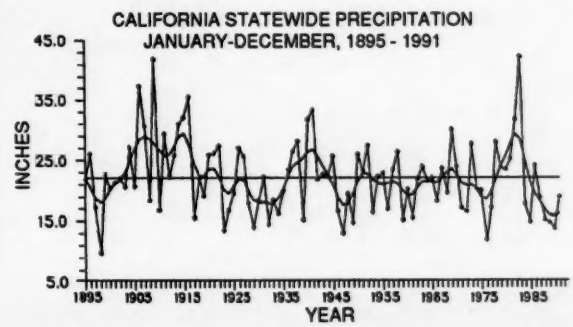
(From *Climate Variations Bulletin*, National Climatic Data Center, NOAA)

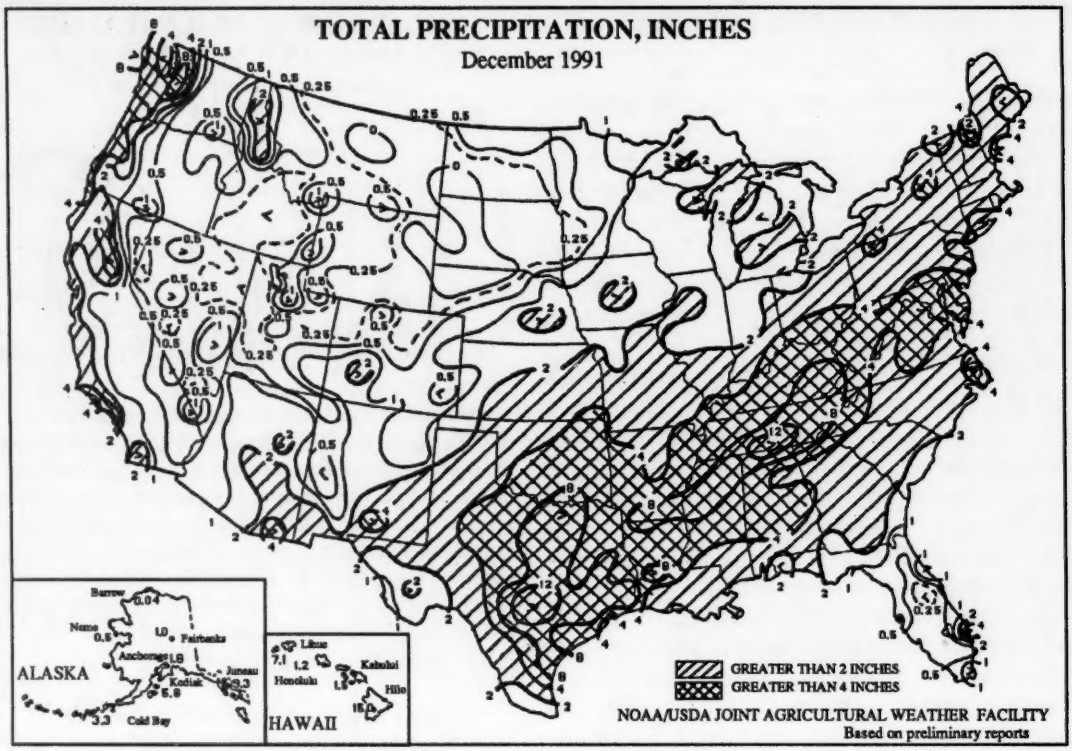


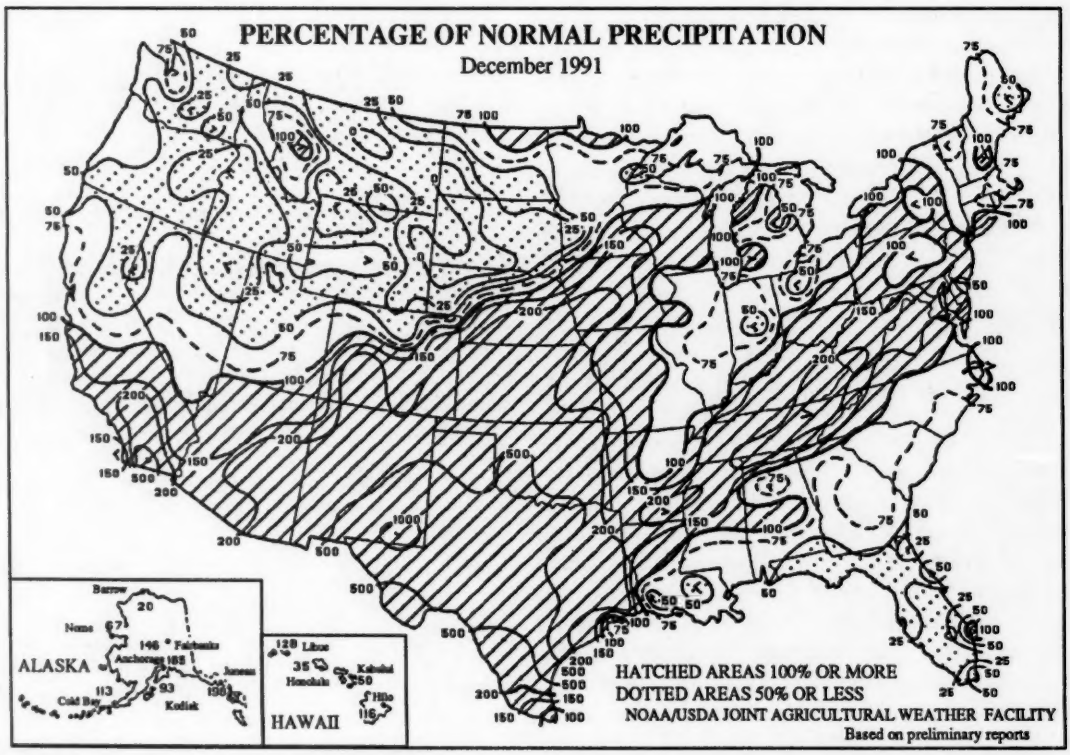
California statewide precipitation for the period January 1982 through December 1991 is shown in the graph above. We see that the December value fell well short of the normal rainfall for the month. For the year, precipitation has been below normal for seven of the twelve months. Looking at the deficit in precipitation from another perspective, the graph below shows the California statewide precipitation for the periods September through December, 1895-1991. We see that the filter curve continued its trend into record deficit values as has been the case for the last two years but the actual value was up somewhat from that of 1990.



California normally experiences a wet season (approximately September-April) that crosses the calendar year; therefore, a calendar-year total will reflect precipitation from parts of two different wet seasons. Statewide precipitation for California has been below normal for the last five calendar years, and below normal for seven of the last eight calendar years, as shown in the graph below.







(From *Weekly Weather and Crop Bulletin* prepared and published by the NOAA/USDA Joint Agricultural Weather Facility)

UNITED STATES DECEMBER CLIMATE IN HISTORICAL PERSPECTIVE

Preliminary data for December 1991 indicate that temperature averaged across the contiguous United States was considerably above the long-term mean. December 1991 ranked as the 14th warmest December on record (the record begins in 1895). The 1991 value is based on preliminary data, which has been shown to be within 0.26 °F of the final data over a 31-month period. About one-sixth (13.5 percent) of the country averaged much above normal for December 1991, with only 1.7 percent averaging much below normal.

Areally-averaged precipitation for the nation was above normal for December (graph at bottom left), which ranked December 1991 as the 27th wettest (71st driest) December on record. This rather damp month helped to bring the filtered curve back to the positive side of normal for the first time since 1985. The preliminary value for precipitation is estimated to be accurate to within 0.15 inches and the confidence interval is plotted below as a '+'. Over one-fifth (21.1 percent) of the country experienced much wetter than normal conditions while another 15.9 percent was much drier than normal.

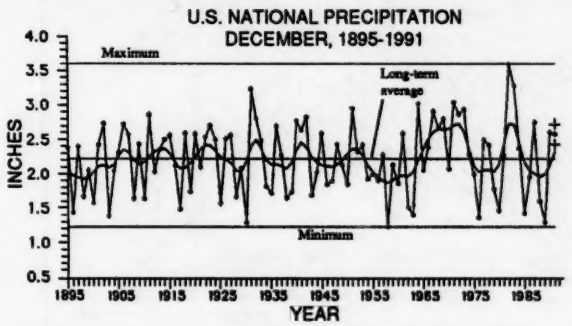
Historical precipitation is shown in a different way in the graph at bottom right. The December precipitation for each climate division in the contiguous U.S. was first standardized using the gamma distribution over the 1951-80 period. These gamma-standardized values were then weighted by area and averaged to determine a national standardized precipitation value. Negative values are drier than the mean while positive values are wetter. This index gives a more accurate indication of how precipitation across the country compares to the local normal climate. The areally-weighted mean standardized national precipitation ranked 1991 as the 55th wettest (43rd driest) December on record.

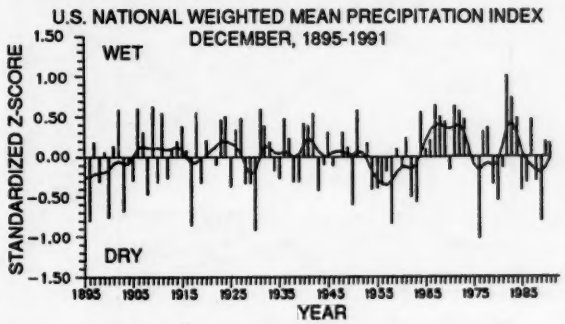
The temperature and precipitation rankings for December 1991 for the nine climatically homogeneous regions in the United States indicate that temperatures were warmer throughout most of the country. Demonstrating the warmer trend, the West North Central region recorded their ninth warmest December on record and the South region had their 15th warmest December since records began in 1895. No regions were in the lower third of the historical distribution for December 1991. Precipitation rankings varied significantly. The Northwest region recorded their 10th driest December ever while the West North Central region recorded their 11th driest December since records began in 1895. Thanks to a more active southerly storm track, the Southwest region recorded significant precipitation giving them their 15th wettest December on record and the South region had their 3rd wettest December in 97 years. The remainder of the country was in the lower to middle third of the historical distribution. For the entire nation, December averaged moderately above normal for precipitation (27th wettest) but temperatures were warmer than the normal (14th warmest).

Long-term drought conditions on a national scale decreased slightly during December. The percent area of the contiguous U.S. experiencing long-term drought (as defined by the Palmer Drought Index) continues to decrease and is currently about seven percent. At the same time, the percent area experiencing long-term wet conditions has increased to the fourteen percent range.

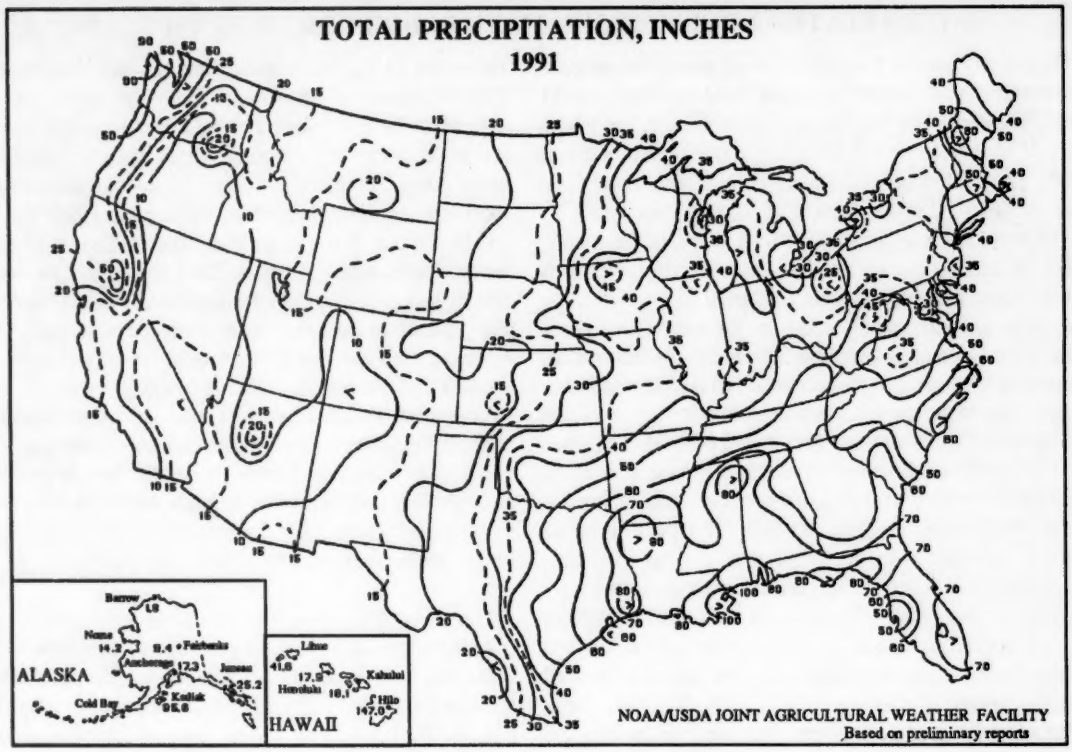
Ten River Basin areas were in the top third wettest of the distribution for the hydrologic year, now three months old. Of these ten, four experienced their top ten wettest October through December period since records began in 1895. Topping the list is the Great Lakes Basin which had their sixth wettest period on record. The Upper Mississippi Basin had their seventh wettest October through December period on record, the Arkansas-White-Red River Basin had their eighth wettest period on record while the Texas Gulf Coast Basin had their ninth wettest such period since records began in 1895. On the other hand, the driest was the South Atlantic-Gulf Coast Basin which had their 12th driest such hydrologic period on record.

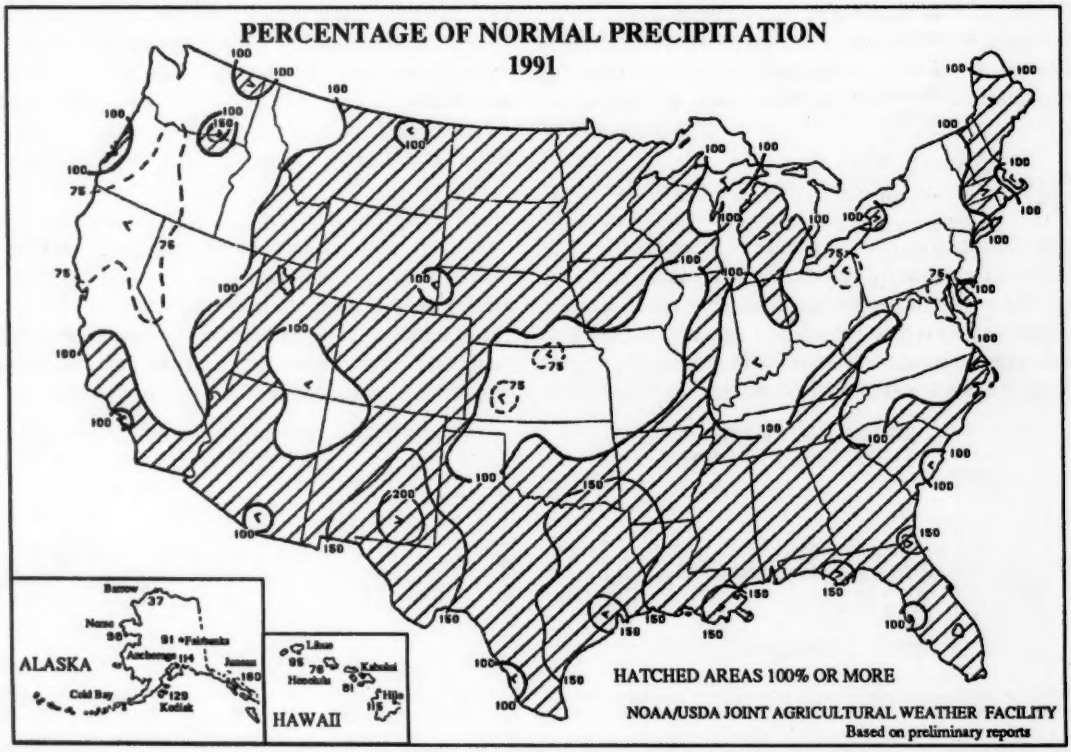
According to preliminary data from the National Weather Service, there were six tornadoes across the United States in December 1991, which is considerably below the 1953-1990 average of 19. It should be noted that the preliminary tornado count is generally higher than the final count. In 1990, for example, the preliminary count for the year was about 19 percent higher than the final count for the same period.





(From *Climate Variations Bulletin*, National Climatic Data Center, NOAA)





(From *Weekly Weather and Crop Bulletin* prepared and published by the NOAA/USDA Joint Agricultural Weather Facility)

UNITED STATES 1991 CLIMATE IN HISTORICAL PERSPECTIVE

Preliminary annual data for 1991 indicate that temperature averaged across the contiguous United States was much above the long-term mean, ranking 1991 as the thirteenth warmest year on record (the record begins in 1895). About one-fifth (19.9%) of the nation had average annual temperatures much warmer than normal, while less than one percent (0.6%) averaged in the very cold category. Five of the last six years have averaged well above normal. The aggregate warmth of these six years has reached the level of the 1930's decade.

The spatial pattern of annual temperatures was fairly uniform. The Southwest region had an annual temperature ranking in the middle third of the historical distribution, but the rest of the country ranked in the warm third of the distribution. The warmest rankings were in the northeastern third of the nation, with the Northeast, Central, and East North Central regions all ranking in the top ten warmest category. On a state-by-state basis, 20 states ranked in the top ten warmest category, with two (Delaware and Maryland) having the second warmest year on record.

The temporal pattern of temperatures for 1991 shows that, with the exception of November, all of the months of 1991 had national temperatures averaging near to well above normal. The warmest temperature departures occurred during February through May, and in December. Nearly half of the country had very warm temperatures in February and nearly a third in May. More than half of the months had at least a small part of the country in the very cold category, but most of the time there was a larger area very warm than very cold.

November began with a severe cold wave and ended with a significantly below-normal national temperature, nearly a fifth of the country averaging very cold or colder, and a total of 575 daily record low temperatures reported.

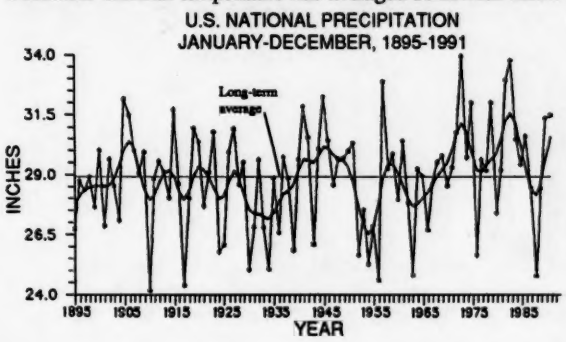
The significance of the unusual warmth during February through May becomes clearer if the year is broken down into two halves: January-June and July-December. January-June 1991 ranked as the eighth warmest first half-year on record. However, 11 of the last 12 years have had national January-June temperatures near to well-above normal, with the last six years consistently averaging warmer than normal. This persistent unusual warmth during the last six years is unprecedented. The warmth generally has not continued, however, into the second half of the year. July-December 1991 ranked as the 29th warmest second half-year on record. The July-December national temperature has averaged somewhat below normal for the last ten years. The decade of the 1930's still holds claim to unprecedented July-December warmth. The warmth of the 1980's and early 1990's in the United States is largely a first half-year phenomenon while the warmth of the 1930's was more of a year-round phenomenon with emphasis on the second half-year.

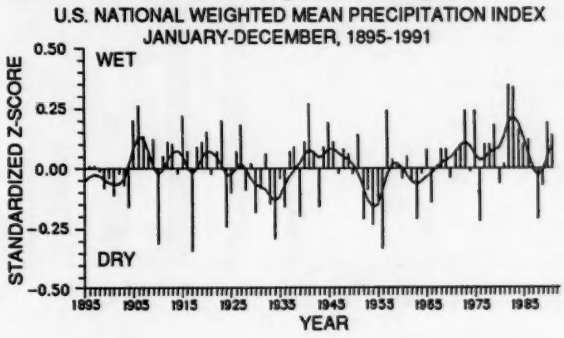
Areally-averaged precipitation for the nation was much above the long-term mean (graph on bottom left), ranking 1991 as the eleventh wettest (87th driest) year on record. The last two years mark a return to the wetness which prevailed during much of the last two years.

Historical precipitation is shown in a different way in the graph at bottom right. The annual precipitation for each climate division in the contiguous U.S. was first standardized using the gamma distribution over the 1951-80 period. These gamma-standardized values were then weighted by area and averaged to determine a national standardized precipitation value. Negative values are dry, positive are wetter than the mean. This index gives a more accurate indication of how precipitation across the country compares to the local normal climate. The areally-weighted mean standardized national precipitation ranked 1991 as the 17th wettest (81st driest) year on record. Annual precipitation totals over one-sixth (15.8%) of the nation were much wetter than normal during 1991 while less than one percent (0.8%) averaged very dry.

February was, relatively, the driest month, with over a fourth of the nation having much below-normal precipitation. Half of the months (January, March-May, and November-December) had more than ten percent of the nation unusually wet. April and December each had notable areas in one extreme or the other. Most months, however, had areas that were unusually dry and areas that were unusually wet.

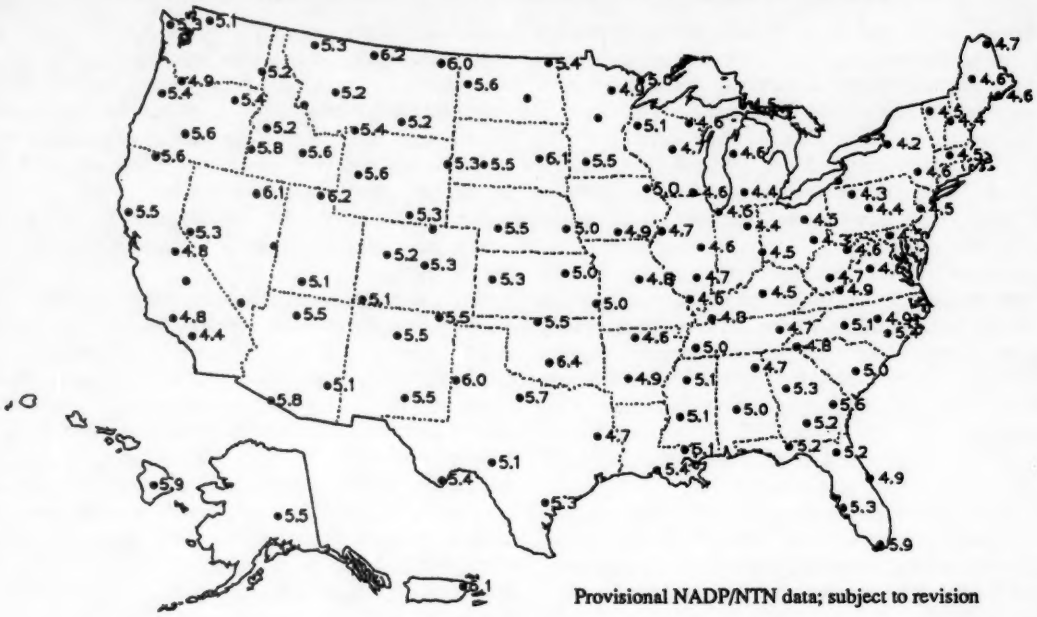
The annual precipitation rankings for 1991 for the nine climatically homogeneous regions in the United States indicate that the Southeast region and the central third of the country ranked in the wet third of the historical distribution, while the two ends (the Northwest, West, and Northeast regions) had precipitation rankings in the dry third of the distribution. Three states (Maryland, Ohio, and Pennsylvania) ranked in the top ten driest category. Nine states had the tenth wettest, or wetter, year in 1991 while one state (Louisiana) ranked wettest on record. Near-record precipitation fell in the Texas Gulf Coast and Lower Mississippi basins (with each ranking second wettest year on record), while the Mid-Atlantic basin ranked near the top ten driest category.





(From *Climate Variations Bulletin*, National Climatic Data Center, NOAA)

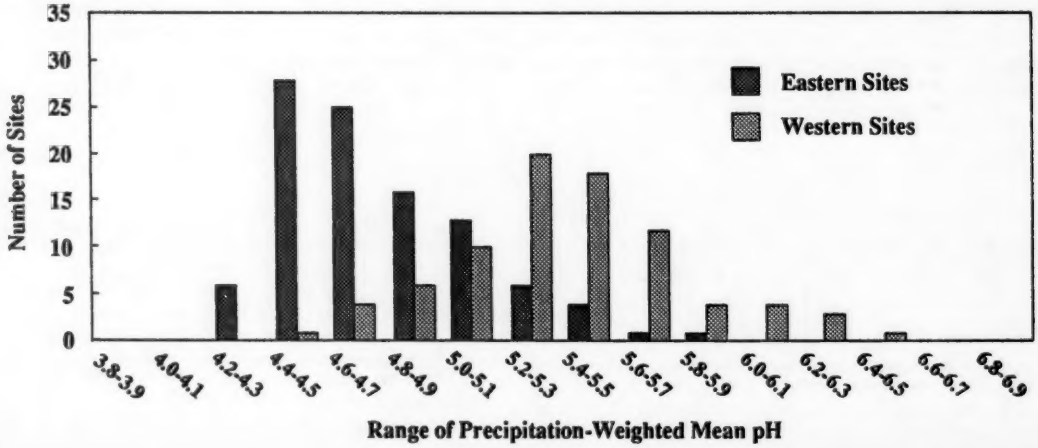
pH of Precipitation for November 25-December 22, 1991



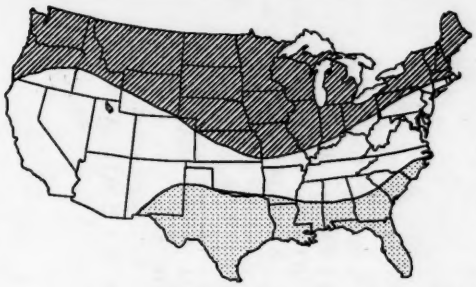
Current pH data shown on the map (• 4.9) are precipitation-weighted means calculated from preliminary laboratory results provided by the NADP/NTN Central Analytical Laboratory at the Illinois State Water Survey and are subject to change. The 128 points (•) shown on this map represent a subset of all sites chosen to provide relatively even geographic spacing. Absence of a pH value at a site indicates either that there was no precipitation or that data for the site did not meet preliminary screening criteria for this provisional report.

A list of the approximately 200 sites comprising the total Network and additional data for the sites are available from the NADP/NTN Coordination Office, Natural Resource Ecology Laboratory, Colorado State University, Fort Collins, CO 80523.

Distribution of precipitation-weighted mean pH for all NADP/NTN sites having one or more weekly samples for November 25-December 22, 1991. The East/West dividing line is at the western borders of Minnesota, Iowa, Missouri, Arkansas, and Louisiana.



TEMPERATURE OUTLOOK FOR JANUARY-MARCH 1992



PRECIPITATION OUTLOOK FOR JANUARY-MARCH 1992

From *Monthly and Seasonal Weather Outlook* prepared and published by the National Weather Service

NATIONAL WATER CONDITIONS

DECEMBER 1991

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EXPLANATION OF DATA (Revised December 1990)

Cover map shows generalized pattern of streamflow for the month based on provisional data from 186 index gaging stations—18 in Canada, 166 in the United States, and 2 in the Commonwealth of Puerto Rico. Alaska, Hawaii, and Puerto Rico inset maps show streamflow only at the index gaging stations that are located near the point shown by the arrows. Classifications on map are based on comparison of streamflow for the current month at each index station with the flow for the same month in the 30-year reference period, 1951-80. Shorter reference periods are used for one Canadian index station, two Kansas index stations, and the Puerto Rico index stations because of the limited records available.

The ***streamflow ranges map*** shows where streamflow has persisted in the above- or below-normal range from last month to this month and also where streamflow is in the above- or below-normal range this month after being in a different range last month. Three ***pie charts*** show: the percent of stations reporting discharges in each flow range for both the conterminous United States and southern Canada, and also the percent of area in each flow range for the conterminous United States and southern Canada. The ***combination bar/line graph*** shows the percent departure of the total mean from the total median flow (1951-80) and the cumulative departure from median (in cfs) for all reporting stations (excluding eight large river stations indicated by # in the ***Flow of large rivers*** table) in the conterminous United States and southern Canada.

The comparative data are obtained by ranking the 30 flows for each month of the reference period in order of decreasing magnitude—the highest flow is given a ranking of 1 and the lowest flow is given a ranking of 30. Quartiles (25-percent points) are computed by averaging the 7th and 8th highest flows (upper quartile), 15th and 16th highest flows (middle quartile and median), and the 23rd and 24th highest flows (lower quartile). The upper and lower quartiles set off the highest and lowest 25 percent of flows, respectively, for the reference period. The median (middle quartile) is the middle value by definition. For the reference period, 50 percent of the flows are greater than the median, 50 percent are less than the median, 50 percent are between the upper and lower quartiles (in the normal range), 25 percent are greater than the upper quartile (above normal), and 25 percent are less than the lower quartile (below normal). Flow for the current month is then classified as: in the ***above-normal range*** if it is greater than the upper quartile, in the ***normal range*** if it is between the upper and lower quartiles, and in the ***below-normal range*** if it is less than the lower quartile. Change in flow from the previous month to the current month is classified as ***seasonal*** if the change is in the same direction as the change in the median. If the change is in the opposite direction of the change in the median, the change is classified as ***contraseasonal*** (opposite to the seasonal change). For example: at a particular index station, the January median is greater than the December median; if flow for the current January increased from December (the previous month), the increase is seasonal; if flow for the current January decreased from December, the decrease is contraseasonal.

Flood frequency analyses define the relation of flood peak magnitude to probability of occurrence or recurrence interval. ***Probability of occurrence*** is the chance that a given flood magnitude will be exceeded in any one year. ***Recurrence interval*** is the reciprocal of probability of occurrence and is the average number of years between occurrences. For example, a flood having a probability of occurrence of 0.01 (1 percent) has a recurrence interval of 100 years. ***Recurrence intervals imply no regularity of occurrence***; a 100-year flood might be exceeded in consecutive years or it might not be exceeded in a 100-year period.

Statements about ***ground-water levels*** refer to conditions near the end of the month. The water level in each observation well is compared with average level for the end of the month determined from the entire period of record for that well. ***Changes in ground-water levels***, unless described otherwise, are from the end of the previous month to the end of the current month.

Dissolved solids and temperature data are given for five stream-sampling sites that are part of the National Stream Quality Accounting Network (NASQAN). ***Dissolved solids*** are minerals dissolved in water and usually consist predominately of silica and ions of calcium, magnesium, sodium, potassium, carbonate, bicarbonate, sulfate, chloride, and nitrate. ***Dissolved-solids discharge*** represents the total daily amount of dissolved minerals carried by the stream. ***Dissolved-solids concentrations*** are generally higher during periods of low streamflow, but the highest dissolved-solids discharges occur during periods of high streamflow because the total quantities of water, and therefore total load of dissolved minerals, are so much greater than at times of low flow.

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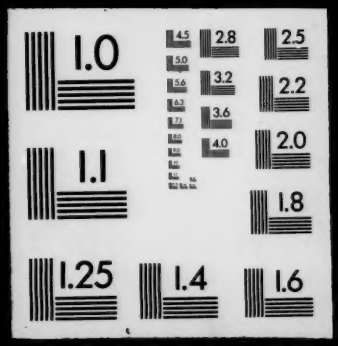
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